

CS105VC

POWER SUPPLIES UNLIMITED

No AF T.O. on this equipment



CAL LAB
HARRIS TECHNICAL SERVICES
3888 Calle Fortunada, Ste. A
San Diego, CA 92123

NJE CORPORATION

KENILWORTH, NEW JERSEY

A SUBSIDIARY OF



CORPORATION

324

INSTRUCTION MANUAL
for
NJE CUSTOM MODEL CS-10SVC-30

VOLTAGE AND/OR CURRENT REGULATED
D.C. POWER SUPPLIES

SERIAL NUMBER _____

NJE CORPORATION

20 BORIGHT AVENUE, KENILWORTH, NEW JERSEY 07033



TELEPHONE: 201-272-6000

802297

TELEFAX - FFP

TWX-201-276-7630

WARRANTY

NJE Corporation warrants all power supplies manufactured by it, to be free from defects in material or workmanship. Our liability, under this warranty, is limited to servicing, or adjusting any instrument returned to the factory or to an NJE field service center for that purpose, and to replacing any defective parts thereof. This warranty is made to the original purchaser and applies to all standard catalog listed equipment for ten* years after delivery to the original purchaser. The provisions of this warranty shall not apply to any power supply which has been subject to misuse or which has been repaired or altered by the purchaser in any way so as, in the judgement of NJE Corporation, to adversely affect its performance or reliability, nor to normal deterioration of appearance due to wear or exposure.

*Warranty applies for one year on High Voltage Supplies.

WARNING

THIS EQUIPMENT EMPLOYS VOLTAGES WHICH ARE DANGEROUS
AND CAN BE FATAL IF CONTACTED BY OPERATING PERSONNEL.
EXTREME CAUTION MUST BE EXERCISED WHEN WORKING WITH
THIS EQUIPMENT.

INTRODUCTION

DEVIATIONS:

This manual covers the Standard NJE Power Supplies as indicated in Section I herein. Where deviations to the specifications are built into equipment at the customer's request, the nature of the deviation as it affects this manual is indicated in a Specification Sheet which precedes Section I. If special Schematic Diagrams, Parts Placement Drawings and/or Spare Parts List(s) are required for the deviation, they will be found in Section V of the manual, in place of, or along with the Standard material.

CORRESPONDENCE:

All correspondence must reference the complete description of the unit as shown on the identification label located at the rear of the power supply.

In requesting Spare Parts or information relative to parts, the Reference Designation, the rating, the description, and the NJE Part Number must be specified for each part in question.

DESIGN IMPROVEMENTS:

NJE Corporation reserves the right to make design improvements on any instrument without prior notice.

REPRODUCTION:

No written material, drawings, text figures, or any part of this Instruction Manual may be reproduced without express written consent of NJE Corporation.

801595

Rev. A.: 6/19/67

REPAIR SERVICE

NJE Corporation provides complete repair facilities at the main plant and at local service centers as listed in the rear of the manual. These repair facilities are adequately staffed with factory trained technicians to assure our customers of the most knowledgeable and expedient servicing of our equipment. All equipment forwarded to these facilities must be adequately packaged to prevent damage in transit.

OUT OF WARRANTY SERVICE:

Forward defective equipment to factory or local service center prepaid. A full description of difficulties encountered or the repair required should accompany this shipment. An estimate of the cost of repair will be submitted to you. The necessary servicing will be performed only upon receipt of your written service orders. Your equipment will be returned to you via collect shipment unless otherwise specified on your service order.

IN WARRANTY SERVICE:

If, during the warranty period the power supply indicates an inherent defect, immediately communicate with your nearest NJE Field Representative in your area. If, after examination, he concurs that the unit is defective under the warranty conditions, he will provide written authorization for the return of the unit to the factory or the local field service center, whichever is nearer. NJE Corporation will not assume any transportation charges on incoming equipment without the concurring written approval from its field representative.



Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_10128

TABLE OF CONTENTS

SECTION	TITLE	PAGE OR NJE DWG. NO.
I	SPECIFICATION DRAWING	111713
	OUTLINE DRAWING	PART OF 111713
	INTERFACE DRAWING	PART OF 111713
II	INSTALLATION AND OPERATION	
	2.1 UNPACKING	2-1
	2.2 INSTALLATION	2-1
	2.3 STANDARD SINGLE UNIT ELECTRICAL	thru
	INSTALLATION	2-3
	2.4 DUALLING	2-4
	2.5 OPERATION	2-4 thru 2-6
III	THEORY OF OPERATION	
	3.1 GENERAL	3-1
	3.2 DETAILED CIRCUIT DESCRIPTION	3-2
	3.2.1 INPUT CIRCUIT - A. C.	3-2 thru 3-5
	3.2.2 INPUT CIRCUIT - D. C.	3-6 thru 3-8
	3.2.3 BIAS VOLTAGE SUPPLIES	3-8
	3.2.4 VOLTAGE AMPLIFIER	3-9 thru 3-10
	3.2.5 CURRENT AMPLIFIER	3-10 thru 3-11
	3.2.6 MODE LAMP SWITCHING	3-12
IV	MAINTENANCE	
	4.1 GENERAL	4-1
	4.2 PREVENTATIVE MAINTENANCE	4-2
	4.3 MEASUREMENTS AND TESTS	4-3 thru 4-5
	4.4 TROUBLESHOOTING	4-5
	4.5 ALIGNMENT AND ADJUSTMENT	4-6
	4.6 ERROR-DIFFERENTIAL AND SECONDARY	
	REGULATION AMPLIFIER CHECK	4-7
	4.7 STABILITY CHECK	4-8
V	SCHEMATIC DIAGRAM	701474
	PART PLACEMENT DRAWING - HEAT SINK ASSEMBLY	111361
	PART PLACEMENT DRAWING - HEAT SINK ASSEMBLY	111362
	PART PLACEMENT DRAWING - HEAT SINK ASSEMBLY	111835
	PART PLACEMENT DRAWING - RESISTOR ASSEMBLY	111836
	PART PLACEMENT DRAWING - RESISTOR ASSEMBLY	111837
	PART PLACEMENT DRAWING - CONVERTER ASSEMBLY	111834
	PART PLACEMENT DRAWING - AMPLIFIER ASSEMBLY	111909
	PART PLACEMENT DRAWING - MAIN ASSEMBLY	111838
	SPARE PARTS LIST	

LIST OF ILLUSTRATIONS

FIGURE 1-1	TYPICAL OPERATION CURVES
FIGURE 2-1	SERIES CONNECTION
FIGURE 3-1	BLOCK DIAGRAM
FIGURE 3-2	WAVEFORMS CROSS REFERENCED WITH VOLTAGE LEVELS
FIGURE 3-3	DISCHARGING SLOPE OF TIME BASE CAPACITOR
FIGURE 4-1	MEASUREMENT CONNECTIONS WITH LOCAL SENSING AND REMOTE SENSING
FIGURE 4-2	VOLTAGE REGULATION CHECK TYPICAL LAYOUT
FIGURE 4-3	CURRENT REGULATION CHECK TYPICAL LAYOUT

↓

SPECIFICATION

1. ELECTRICAL SPECIFICATIONS:

1.1 INPUT:

- 1.1.1 A.C.: 105-125V, 50-60Hz single phase at approximately 16 amperes.
- 1.1.2 D.C.: 17-24V in two ranges (17-20V or 20-24V) at approximately 35 amperes.

1.2 OUTPUT: 0-10VDC at 0-30 amperes.

1.3 REGULATION:

1.3.1 Line:

- 1.3.1.1 Constant Voltage Mode: Less than 0.01% or $\pm 2\text{MV}$ for an input line change of 105-125VAC (50-60Hz) or 17-20VDC or 20-24VDC at constant load.
- 1.3.1.2 Constant Current Mode: Less than 0.05% or $250\mu\text{A}$ for an input line change of 105-125VAC (50-60Hz) or 17-20VDC or 20-24VDC at constant load.

1.3.2 Load:

- 1.3.2.1 Constant Voltage Mode: Less than 0.01% or $\pm 1\text{MV}$ for a no load to full load change.
- 1.3.2.2 Constant Current Mode: Less than 0.05% or 3MA/Volt change in output for an output voltage change of 0.5 - 10VDC.

1.4 RIPPLE AND NOISE:

- 1.4.1 Constant Voltage Mode: $500\mu\text{V}$ (RMS) maximum for any combination of input line voltage and/or frequency and/or output load current.
- 1.4.2 Constant Current Mode: 0.05% or 25MA (RMS) maximum for any combination of input line voltage and/or frequency and/or output load voltage of 0.5 - 10VDC.

1.5 PROTECTION: Fuses to be provided in AC and DC input lines.

1.6 POLARITY: The output may be "floated" up to 500V. **peak** above chassis ground. Either of the output leads may be grounded to the chassis.

1.7 METERS: Output voltmeter and ammeter to be provided on front panel. Accuracy of each meter $\pm 2\%$ of full scale.

1.8 DUTY: Continuous at 23°C ambient.

2. MECHANICAL SPECIFICATIONS: See Figure 1. and Figure 2.

N J E CORPORATION
KENILWORTH, N. J.

SIZE

CODE IDENT NO.

DWG NO.

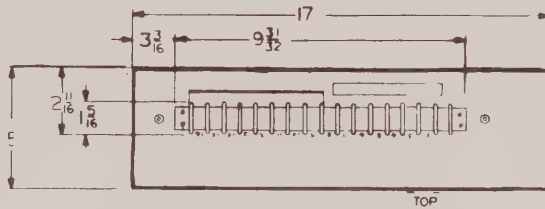
98380

111713

SCALE

REV

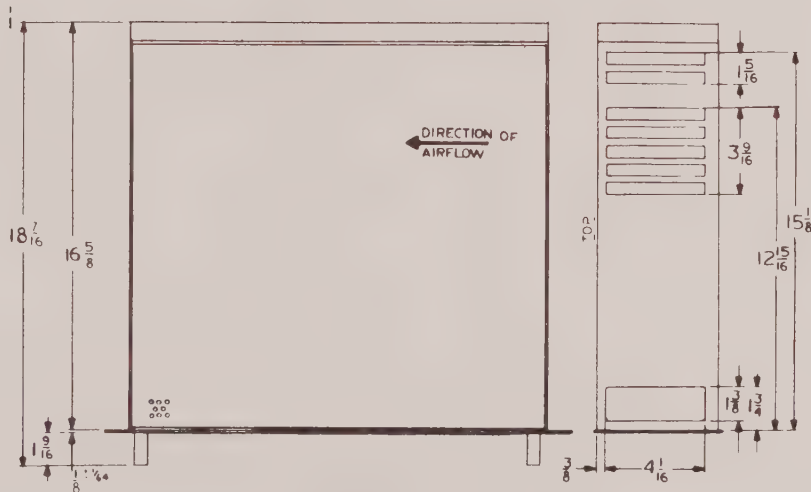
SHEET 2



NOTE

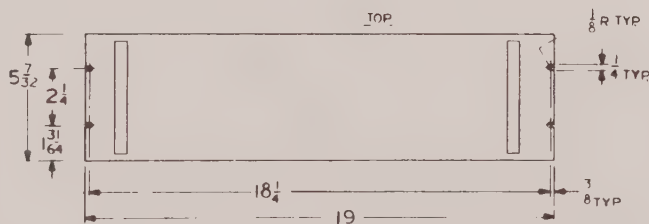
ALL TOLERANCES $\pm \frac{1}{32}$
UNLESS OTHERWISE
SPECIFIED.

REAR VIEW



PLAN VIEW

LH SIDE VIEW



FRONT VIEW

OUTLINE DWG FIG-1

N J E CORPORATION
KENILWORTH, N. J.

SIZE
A

CODE IDENT NO.
98380

DWG NO.

111713

SCALE NONE

REV

SHEET **4**

TYPICAL OPERATION CURVES

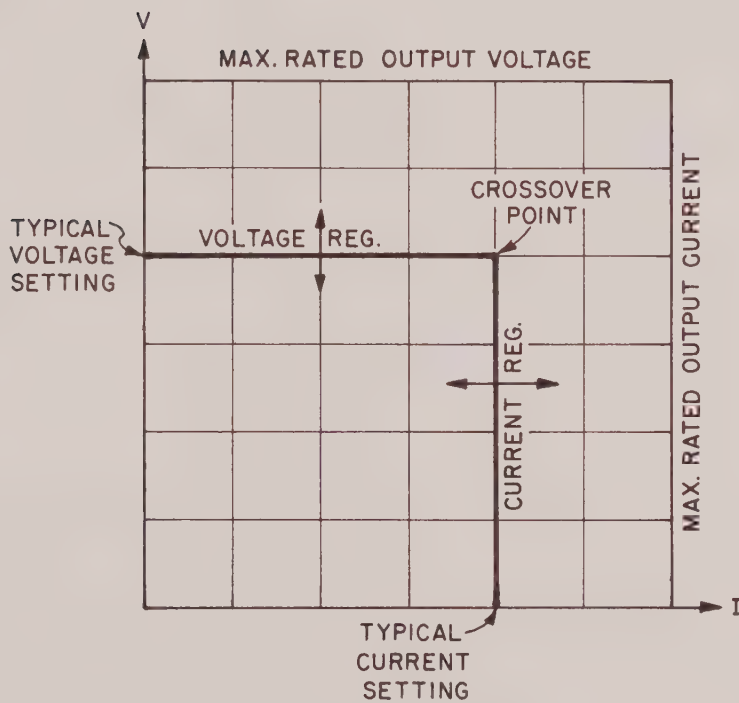


FIG. 1-1

SECTION II

INSTALLATION AND OPERATION

2.1 UNPACKING: The power supply is shipped in a corrugated carton which is floated on sufficient insulation in a heavy-duty shipping carton. Aside from normal precaution against damage to the unit in opening the cartons and removing the unit, no special procedures are required. The carton should be opened immediately upon receipt and the contents inspected for shipping damage. The Power Supply was checked electrically and mechanically before it left the factory, and is warranted to be in perfect operating condition. This warranty does not cover possible damage incurred during shipment. Therefore, any evidence of mishandling, such as broken, deformed or missing parts, should be brought to the attention of the transportation company and a claim should be entered. Remove top cover plate and inspect all components and wiring, both on the chassis and panel, as well as the mechanical condition of the housing. The literature packed with the supply should be removed and held for reference in operating the equipment.

2.2 INSTALLATION: Refer to the Outline and Interface Drawings. These drawings show mounting dimensions, air flow requirements, interface wiring information and other data pertinent to proper installation. Careful observance of all the specification requirements in Section I is essential to a proper installation. READ THE SPECIFICATIONS CAREFULLY BEFORE PROCEEDING.

When the unit has been properly placed in position on a bench or mounted in a rack and secured in place by the panel screws, electrical connections should be made in accordance with the following step-by-step procedure. Wire sizes to be used and the terminal locations are specified on the Interface Drawing. Terminal functions listed in the following instructions are clearly screened on the equipment itself, as well as being indicated on both the Interface Drawing of Section 1 and the Schematic Drawing of Section 5.

2.3 STANDARD SINGLE UNIT ELECTRICAL INSTALLATION:

2.3.1 Output Grounding: Connect either the positive (POS OUT) or negative (NEG OUT) DC output terminal of the supply (depending upon desired output polarity) directly to the output chassis ground terminal (GRD) on the rear of the chassis, and connect the ground terminal to the system ground.

NOTE: If it is necessary that the power supply circuit float above or above ground, it is recommended that one output terminal should be connected to the chassis ground terminal by a 0.1 microfarad 600 VDC capacitor in place of the direct connection. Use of this by-pass capacitor will improve the stability of the circuit in the ungrounded condition, and reduce the effect of external interference and hum. Refer to Polarity Specification in Section I for maximum limitation on floating voltage permitted.

2.3.2 Output Connection: Connect the positive and negative output terminals (POS OUT) and (NEG OUT), respectively to the corresponding terminals of the external load. Use heavier gauge wire than that specified if long distances to the load are involved.

2.3.3 Remote Sensing: All units are shipped from the factory with the REMOTE SENSING feature jumpered out on the inter-connection terminal board as follows: (POS SENS) connected to (POS OUT) and (NEG SENS) connected to (NEG OUT). With this connection, the regulation specifications are met ONLY at the output terminals of the supply. If it is desired to have accurate regulation at the remote load point, rather than at the output terminals, proceed as follows:

Connect the output terminals to the load per Paragraph 2.3.2 above. Remove the jumpers from (POS SENS) to (POS OUT) and (NEG SENS) to (NEG OUT) respectively. Observing correct polarity, run a shielded pair of No. 20 AWG wire (or larger) from (POS SENS) to the positive load point and from (NEG SENS) to the negative load point.

WARNING!!! DO NOT OPERATE POWER SUPPLY WITHOUT THE SENSING LEADS CONNECTED EITHER REMOTELY OR LOCALLY. MOST CUSTOMER COMPLAINTS OF POOR OPERATION ARE DUE TO IMPROPER SENSING LEAD CONNECTION.

WHEN THE POINT OF REMOTE SENSING IS MORE THAN 10 FEET FROM THE POWER SUPPLY, OSCILLATIONS MAY DEVELOP. A POSSIBLE CURE IS TO CONNECT REMOTE CAPACITANCE AS DESCRIBED IN PARAGRAPH 2.3.4 AND AS CLOSE TO THE POINT OF SENSING AS IS PHYSICALLY POSSIBLE.

2.3.4 Output Capacitor Connections: This feature is provided on all units. The terminals are listed as (POS CAP) and (NEG CAP) on the Interface Drawing. The power supply has been shipped from the factory with the appropriate filter capacitors connected to the appropriate output terminals at the interconnection terminal board. This arrangement is satisfactory for most applications. However, if better transient and dynamic characteristics are required, further improvement can be effected by using an independent capacitor mounted as close to the ultimate load as is practical.

The capacitor used should have the same voltage rating of the power supply output capacitance (see the Schematic Drawing for the rating of the capacitor connected to the (POS CAP) and (NEG CAP) terminals) and at least the same capacitance rating should be used. Additional

capacitors may be ordered by specifying the NJE Part Number of the output capacitor from the Spare Parts List of Section 5.

Reconnections are made as follows: Remove the jumper connection provided between (POS OUT) and (POS CAP) and between (NEG OUT) and (NEG CAP). The load leads should be connected as in Paragraph 2.3.2 above. Connect the new capacitor directly at the load being careful to observe polarity. In order to make this connection effective, it will be necessary to utilize the Remote Sensing Connections described in Paragraph 2.3.3 above.

2.3.5 Remote Programming: To utilize either the Remote Voltage Program or Remote Current Program, remove jumper across the appropriate terminals and connect a resistor across the Remote Program terminals. If the resistor is to be located remotely from the power supply a shielded pair of No. 20 AWG should be used. The resistance (R) of the remote program resistor may be calculated as follows:

2.3.5.1 Remote Voltage Program -

$$R \ (\Omega/V) \ (V_o - V_{\min}) \text{ ohms}$$

Where (R) is the desired resistance, (Ω/V) is the Remote Programming Sensitivity (150 Ω /volt). (V_o) is the desired output voltage and ($V_{\min}$) is the minimum voltage allowed for the power supply.

The VOLTAGE ADJUST potentiometer should be set to zero (extreme counter clockwise) when this connection is used.

2.3.5.2 Remote Current Program -

$$R \ (\Omega/I) \ (I_o - I_{\min}) \text{ ohms}$$

Where (R) is the desired resistance, (Ω/I) is the Remote Programming Sensitivity (33.33 Ω /ampere). (I_o) is the desired output current and ($I_{\min}$) is the minimum current.

The CURRENT ADJUST potentiometer should be set to zero (extreme counter clockwise) when this connection is used.

WARNING!!! DO NOT OPERATE THE POWER SUPPLY WITH EITHER "REMOTE PROGRAM" TERMINALS OPEN CIRCUITED.

2.3.6 Input Connection:

2.3.6.1 These units are supplied with three wire line cord and plug. for AC voltage input. When DC input is employed, connect the proper wire size specified in the Interface Drawing to the two DC input terminals observing that the positive and negative leads are wired to their respective terminals.

2.4 DUALING:

- 2.4.1 Cooling of Dual Unit Installation: Where the dual units are to be rack mounted one directly above the other, filler panels of 1-3/4" minimum height must be used between units. These panels may be ordered from NJE Corporation if the same finish is desired. For standard finish, 1-3/4" by 19" filler panels, order NJE Part No. 22164.
- 2.4.2 Series Connection: These Power Supplies may be connected in series, as indicated in Figure 2-2A. The series connection is quite straight forward and is essentially the same as connecting two batteries in series. Each supply is independently controlled and delivers an output voltage within its own capability. The total output voltage is, of course, the sum of that of the two supplies.

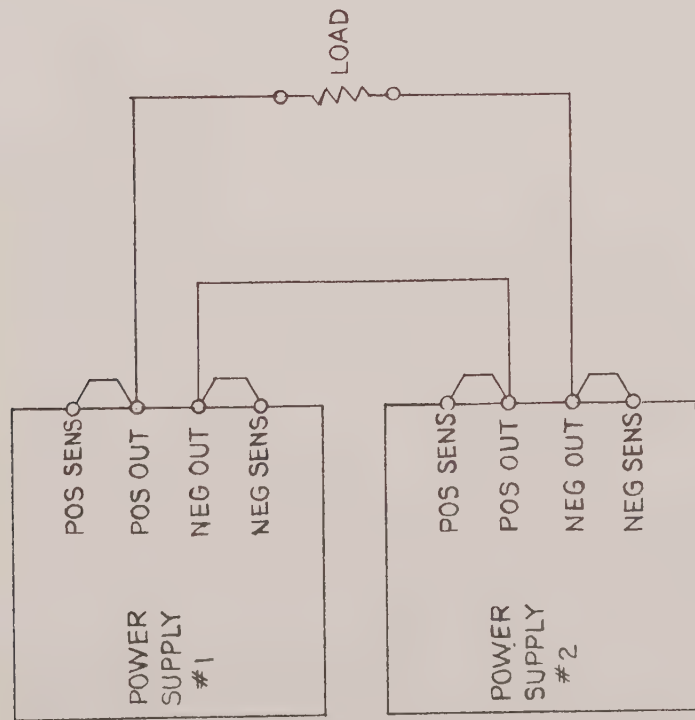
2.5 OPERATION:

- 2.5.1 The following check list should be followed before making the unit operational:
- 2.5.1.1 Power Switch in the OFF position.
 - 2.5.1.2 VOLTAGE ADJUST potentiometer in the extreme counter clockwise position.
 - 2.5.1.3 CURRENT ADJUST potentiometer in the extreme clockwise position.
 - 2.5.1.4 Input wiring made per Paragraph 2.3.6.
 - 2.5.1.5 Output Grounding wired per Paragraph 2.3.1.
 - 2.5.1.6 Output wiring made per Paragraph 2.3.2.
 - 2.5.1.7 Remote Sensing wiring made per Paragraph 2.3.3.
 - 2.5.1.8 Output Capacitor wiring made per Paragraph 2.3.4.
 - 2.5.1.9 Remote Programming wiring made per Paragraph 2.3.5.
 - 2.5.1.10 Dualling connection (where desired) made per Paragraph 2.4.
- 2.5.2 Step by step operation based on the location of controls as indicated on the Interface Drawing:

- 2.5.2.1 Energize the input line.
- 2.5.2.2 Operate the main power switch to the DC or AC position. The input power pilot lamp should lite.
- 2.5.2.3 While monitoring both output voltage and current, slowly rotate the VOLTAGE ADJUST potentiometer clockwise until the desired voltage level is reached.
 - 2.5.2.3.1 If the desired voltage and/or current level (within the ratings of the unit) cannot be reached, de-energize the input line and re-check all connections per Paragraph 2.5.1 above. If still unable to achieve the desired levels, refer to the Trouble Shooting Section at the rear of the manual.
- 2.5.2.4 CURRENT ADJUST may be set to the desired level as follows:
 - 2.5.2.4.1 Method #1: While monitoring the load current, apply a short circuit across the load and rotate the CURRENT ADJUST potentiometer counter clockwise until the desired current level is reached.
 - 2.5.2.4.2 Method #2: While monitoring the load voltage and current, adjust the load so that the desired levels are reached. Rotate the CURRENT ADJUST potentiometer slowly counterclockwise until the current level begins to fall off.
 - 2.5.2.4.3 Method #3: Leaving the CURRENT ADJUST control at the extreme clockwise position sets the current limiting action at approximately 110% of the maximum current rating of the supply.
 - 2.5.2.4.4 These units are provided with MODE lamps. When the above step is performed, the VOLTAGE MODE lamp should extinguish and the CURRENT MODE lamp should light. A slight clockwise adjustment of the CURRENT ADJUST potentiometer will then set the current limiting just above the operating level. The VOLTAGE MODE lamp should now light and the current mode lamp should extinguish.

NOTE 1:

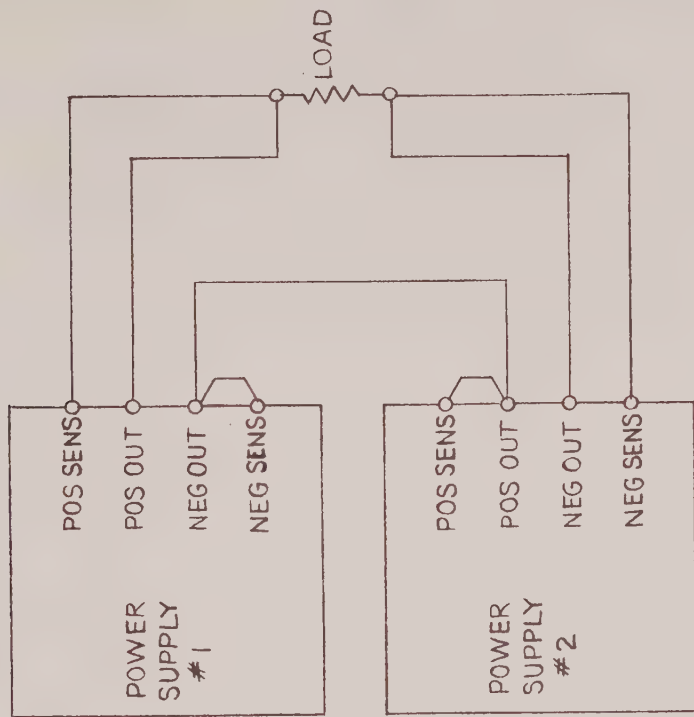
The current limiting feature is essentially a constant current device. As the load resistance is reduced toward an eventual short circuit condition, the load current will be limited to the preset CURRENT ADJUST control setting, and it will hold at this value as the output voltage falls toward zero. The current regulation parameters are in accordance with the specifications of Section I, as the load resistance varies to cause a full swing of output voltage and is proportionally better for smaller load resistance changes.



LOCAL SENSING

NOTE:

- 1) SEE INTERFACE DRAWING, SECTION I, FOR TERMINAL CONNECTIONS AND WIRE SIZES.



REMOTE SENSING

SERIES CONNECTION

FIG.2-1

THEORY OF OPERATION3.1 GENERAL:

A simplified Block Diagram, illustrating the basic elements of the circuit and the signal flow, is shown in Figure 3-1. The unit may be operated from either an A.C. or D.C. input line voltage.

When operating from an A.C. input line voltage, the incoming voltage is transformed to adequate values by the main power transformer to supply a bridge rectifier. The average value of the output voltage from the bridge rectifier is filtered by a capacitor input filter.

The average voltage across the capacitor input filter (C1) is controlled by a pair of SCR's arranged as part of the bridge rectifier. These SCR's can be considered as the On-Off switching elements whose condition (conductivity) varies to adjust for line and/or load changes such that the voltage across the series regulator transistors is maintained at a level sufficient to supply the necessary D.C. output voltage of the power supply, but low enough to maintain the series regulator transistors within their dissipation capabilities.

The SCR firing circuit and control amplifier bias voltages are obtained from auxiliary transformer windings and associated A.C. to D.C. rectifier and filter systems.

When operating from a D.C. input line voltage, the incoming voltage is fed directly to the series regulator transistors or through a voltage dropping resistor (A7R1) depending on the input voltage level. Input voltage to the amplifier bias transformer, unit blower and pilot lamp are provided by a D.C. to A.C. converter through bias switch relay (K1). The converter operates from a regulated voltage supplied by converter regulator (A3).

A transistor series regulator (consisting of six power transistors operating in parallel) provides high speed regulating action to correct for ripple and transient voltage variations both at its input and at the output of the supply.

Feedback amplifier loops provide correction signals to the series regulator from signals derived from output voltage and current. In the constant voltage mode, the output voltage furnished to the load by the series regulator is monitored by a feedback amplifier, which compares this voltage with a stabilized reference voltage, and amplifies the difference between the two voltages. The output of the amplifier is used to control the series regulator so that it counteracts any change in the D.C. output voltage, thereby furnishing an essentially constant voltage to the external load.

(3.1 Cont'd.)

In the constant current mode, the output current furnished to the load by the series regulator is monitored by a second feedback amplifier which compares the voltage drop across a series resistor with a stabilized reference voltage and amplifies the difference between the two voltages. The output of this amplifier follows the same control path as the constant voltage mode and is used to control the series regulator so that it counteracts any change in the DC output current thereby furnishing an essentially constant current to the external load.

3.2 DETAILED CIRCUIT DESCRIPTION:

Circuit references in the following material apply to the Schematic Diagram at the back of the manual. This diagram shows Electrical Relationships, and is laid out in an arrangement approximately the same as that of the Block Diagram, Figure 3-1.

3.2.1 INPUT CIRCUIT - A.C.:

The power supply is energized by connecting 115 volt (nominal) 50-60 cycles, single phase, to the AC input terminals and closing switch (S1) in the AC position, attested by the lighting of pilot lamp (DS1) and starting of fan (B1).

The power transformer (T1) converts the input line voltage to an appropriate value which is rectified to a pulsating DC output voltage by a full wave single phase bridge rectifier, consisting of two (2) SCR's and two (2) standard rectifiers. The DC voltage is then filtered by capacitor (C1) and applied through pass transistor sections (A3 and A4) to the external load.

Capacitor (C2) provides additional filtering of the output, and reduces the internal impedance of the supply for medium frequency load variations. Additional output capacitance is provided by (C6) for further high frequency response improvement and spike suppression.

3.2.1.1 TRIGGER AMPLIFIER:

The silicon controlled rectifier trigger circuitry consists of (A1Q1), (A1Q2), (A1Q3) and (A1Q21) and associated components. The circuit adjusts the storage voltage of the pass transistor by controlling the average value of the voltage across (C1). This is accomplished in a manner analogous to thyatron circuitry in which the rectifiers are "fired", and thereby begin conduction, at some point later than the start of the half-wave cycle. Depending on whether the firing point or phase angle of firing is advanced toward the start of the cycle, or retarded away from the start of the cycle, the average voltage across (C1) will be increased or decreased. The circuit is designed to automatically maintain relatively constant voltage

across the pass transistor section and at a level at which the total dissipation is limited to a safe value. Thus, the phase angle of firing is automatically adjusted, by means of the circuitry to be described above, to hold the pass transistor storage voltage relatively constant regardless of line voltage or load variations, or of output voltage and/or current adjustments. The trigger circuitry consists of essentially three sections: the charging circuit, the discharging circuit and the firing circuit. Each is discussed separately.

3.2.1.1.1 CAPACITOR CHARGING:

The charging circuitry consists of diodes (A1CR1), (A1CR2), (A1CR5), (A1CR7) and its load resistor (A1R1) and capacitor (A1C6). Diode (A1CR6) decouples the junction of (A1CR1-A1CR2) from the bias voltage output capacitor (A1C4). Thus, the junction point of the three diodes follows the transformer auxiliary winding rather than remaining at the capacitor potential; and this point effectively moves along the half-size curve of a typical fullwave configuration. (A1CR5), a zener diode of 12 volts breakdown voltage, establishes that the pulsating DC developed at the junction of (A1CR5) and (A1CR7) is 12V below that developed at (A1CR1-A1CR2).

It is this offset pulsating DC that provides the periodic recharging surge for the timing capacitor (A1C6) and is shown as waveform (B) on Figure 3-2. Note that the rectified pulses are offset 12 volts negative by the zener voltage drop. It therefore follows that capacitor (A1C6) is charged through (A1CR7) (to a level 12V below the auxiliary transformer center tap zero level) once each half cycle as the transformer voltage approaches its zero level.

3.2.1.1.2 CAPACITOR DISCHARGING:

The base of transistor (A1Q1) is held at a potential somewhat below the center tap of the auxiliary transformer winding by means of the divider action of resistors (A1R16), (A1R7) and (A1CR9). The voltage across the divider (A1R16) and (A1R7) is proportional to the storage voltage across the series regulator; and therefore as the load requirements, line variations or output voltage of the supply change, so does the storage voltage and correspondingly the voltage at the

base of (A1Q1) changes. The voltage change at the base of (A1Q1) adjusts the current flow through (A1R10) and (A1Q1), consequently adjusting the rate of the discharge slope of (A1C6). The overall charging and discharging waveform is shown as (D) on Figure 3-2. When the supply needs more power, the slope of the discharging rate will move in the direction of Slope 1 of Figure 3-3, and when less power is required the rate of discharge will move toward Slope 2 of Figure 3-3.

3.2.1.1.3 TRIGGER CIRCUIT:

Transistors (A1Q2) and (A1Q3) are arranged as an astable multivibrator. The base of (A1Q3) is at a fixed reference voltage by voltage divider (A1R14) and (A1R15) and it is conducting when timing capacitor (A1C6) has been recharged. The base of (A1Q2) is tied to timing capacitor (A1C6) through (A1R11), and when the discharge of this capacitor (as measured from the reference) reaches level (E) on Figure 3-2 or 3-3, (A1Q3) is turned OFF and (A1Q2) is turned ON. The "turn OFF" instant of transistor (A1Q3), as expressed in terms of degrees, will vary as seen in Figure 3-3 level (E).

This one short action generates a positive going pulse which is derived across (A1Q3) collector load resistor (A1R12). The pulse is coupled by (A1C7) to turn on (A1Q21). As (A1Q21) conducts through the blocking oscillator transformer (A1T1), an output pulse from (A1T1) triggers the SCR's depending on the particular power rectifier which is in its conducting half cycle. As the slope of the rate of discharge varies due to error amplifier signal, so will the SCR conduction time vary correspondingly to adjust for the line and/or load variations.

3.2.1.2 STORAGE VOLTAGE CONTROL:

Storage voltage control of the series regulator assemblies is achieved in the following manner. The storage voltage tends to increase under conditions of increased input line voltage,

decreased load or decreased output voltage. When this occurs, the potential of the collectors of the series transistors rises with respect to the zero level. The base, and consequently the emitter of (A1Q1) is correspondingly higher thereby reducing the voltage across (A1R10) and reducing the discharge current of (A1C6). Thus, the discharge of (A1C6) requires a longer time and consequently the turn-on of (A1Q2) occurs later in the half-cycle. This in turn causes a shorter firing period for the SCR's with a reduced average voltage at (C1). It is thus seen that when the storage voltage increases, a compensating action occurs which tends to restore the storage voltage to its original level; and a corresponding situation occurs for a decrease of storage voltage. It is further recognized, that the silicon controlled rectifier's output tends to "track" the output voltage, and in this manner maintains the series regulator dissipation within fixed limits. Note that in the above paragraph the term "Storage Voltage" is used to denote the voltage across the series regulator transistor.

3.2.1.3 PEAK POWER PROTECTOR:

The circuitry of (A1Q4) is provided to protect the series regulators from over dissipation during short circuit when the storage voltage across the series regulators may attain a very high value until the silicon controlled rectifier is able to decrease the average voltage across capacitor (C1). This circuit acts as follows: a voltage divider consisting of resistors (A1R18 and A1R19) is connected between the -42 VDC source and the collectors of the series regulators. The junction of these resistors (A1R18 and A1R19) is connected to the base of transistor (A1Q4) whose emitter is tied to the positive output of the supply. If the storage voltage across the series regulator increases beyond the point determined by resistors (A1R18 and A1R19) the transistor (A1Q4) is turned on. This clamps the base of transistor (A1Q8) to the positive output of the supply cutting off its drive current to the series regulators. This action decreases current flow from the series regulator to a very low value until the controlled rectifier decreases the average value of voltage across capacitor (C1). This action keeps the dissipation of the series regulator at a safe value at all times. This circuit overrides the current limiting circuitry during overload conditions on the output of the power supply and is designed to protect the series regulator power transistors.

3.2.2 INPUT CIRCUIT - D.C.:

The power supply is energized by connecting 17-20 or 20-24 VDC to the DC input terminals and closing (S1) in the DC position, attested by the lighting of pilot lamp (DS1) and starting of fan (B1).

The DC input voltage is applied through (S1 and S2) directly to the pass transistor sections (A3 and A4) when the input voltage value lies between 17V and 20V. When the input voltage value lies between 20 and 24V., it is applied to the pass transistor sections (A3 and A4) through a voltage dropping resistor (A7R1).

3.2.2.1 BIAS SUPPLY CONVERTER-GENERAL:

When operating with a DC input voltage, it is necessary to provide a source of AC voltage to supply the amplifier bias transformer (T2), the unit blower (B1) and pilot lamp (DS1). Bias supply converter (A6) together with its associated transformer (T3) provides the necessary source of AC voltage from from the applied DC input source. Due to the wide range of DC input voltage allowable, a regulated source of DC voltage is necessary to maintain the AC output voltage and frequency of the converter within reasonable limits. The converter regulator consists of (A3Q4, A3CR1) and (A3R4).

3.2.2.1.1 CONVERTER REGULATION:

Transistor (A3Q4) is an emitter follower whose input from (S1) is the voltage across the breakdown diode (A3CR1). Resistor (A3R4) provides base drive for (A3Q4) and the "zener" breakdown current for (A3CR1). As the input voltage applied to the collector of (A3Q4) attempts to change from the nominal breakdown voltage value of (A3CR1) the collector to emitter voltage of (A3Q4) will increase or decrease as necessary thus acting as a variable resistor to absorb any input voltage changes.

3.2.2.1.2 D.C. TO A.C. CONVERTER:

(A6Q1, A6Q2 and T3) comprise a self driven transistor oscillator with an autotransformer load winding. As a DC voltage is applied to the circuit across filter capacitor (A6C1), either (A6Q1) or (A6Q2) will be driven into conduction by base current supplied through (A6R1) and decoupling diodes (A6CR2) or (A6CR1).

Consider that (A6Q1) starts conducting. When

Q1 starts to conduct, a voltage is developed across the primary winding of (T3 - terminals 1-2-3), inducing a voltage in the feedback winding that drives the base of (A6Q1) positive and causes increased conduction. Thus the current increases rapidly until the collector of (A6Q1) is driven into the saturation region of its characteristics. When this occurs, the primary voltage can no longer increase and a condition of quasi-stable equilibrium is maintained. During this equilibrium period, the voltage drop in the transistor from collector to emitter is very small and essentially the full supply voltage appears across that half of the transformer primary.

As long as (A6Q1) can supply collector current equal to the total of reflected load current, reflected emitter current and transformer exciting current, this condition will be maintained.

With a constant voltage across the transformer primary, the magnetic flux will increase until the transformer core reaches saturation and the required exciting current increases rapidly to a value greater than can be supplied. As a result, the primary voltage decreases, reducing the emitter voltage and decreasing the collector current. Thus transistor (A6Q1) turns off regeneratively, ending the half cycle.

As the flux collapses in (T3) primary, a voltage is induced in the winding which biases transistor (A6Q2) to conduction, thereby initiating the next half cycle. The operation is identical to the first half cycle with the exception that (A6Q2) conducts until the core of (T3) is driven into negative saturation. After the core saturates, the flux again collapses and the full cycle is complete.

(A6R2) is provided to limit the base drive current of (A6Q1) and (A6Q2) and is selected during test to provide optimum starting characteristics of the unit blower (B1).

(A6C2) suppresses transients which may appear at the bases of (A6Q1) and (A6Q2) during switching.

The square wave output voltage is taken off across (T3 - terminals 1 and 4) and is fed through the contacts of (K1) to supply the bias transformer (T2) the unit pilot lamp (DS1) and the unit blower (B1).

3.2.3 BIAS VOLTAGE SUPPLIES:

The output voltage on the transformer (T2) (auxiliary winding) is rectified by diodes (A1CR13 and A1CR14) and smoothed by capacitor input filter (A1C14) to provide positive and negative operating potentials for the feedback amplifier. The breakdown diode (A1CR18), in conjunction with its load resistor (R32), provides regulated -12 VDC. Breakdown diodes (A1CR20) and (A1CR21), in conjunction with load resistors (A1R37) and (A1R58), provide regulated -6.2 VDC and + 6.2VDC respectively. These breakdown diodes function in a manner analogous to that of a gaseous voltage regulator tube, providing a relatively stable output voltage across their terminals despite variations in the conducted current. The bias voltages for the controlled rectifier trigger circuit, high level amplifiers (A1Q7 and A1Q8), mode lamp switching transistors (A1Q5 and A1Q6) are obtained from the positive and negative voltages developed across (A1CR1 and A1CR2) and (A1CR3 and A1CR4) and their associated capacitor input filters (C4 and C5).

Amplifier bias voltages of approximately + 15 volts and -12 volts are obtained through a series regulator (A1Q10) and filter capacitor (A1C15). (A1C15) filter capacitor is used to smooth out the effects of rapid line and/or load changes. The series regulator is driven by driver transistor (A1Q22) which is driven from a single stage differential pair consisting of (A1Q11) and (A1Q12). The differential action is achieved by comparing the divider voltage derived from resistors (A1R30) and (A1R29) against the reference voltage of (A1CR18). Individual main reference voltage of + 6.2 and -6.2 VDC for both the voltage and current regulating circuitry are derived from the +15 and -12 VDC bias voltage. These consist of breakdown diode (A1CR21) in conjunction with load resistor (A1R58) for voltage reference and breakdown diode (A1CR20) in conjunction with load resistor (A1R37) for current reference.

(A1CR17) and its associated load resistor (A1R33) provide a regulated voltage for the base drive resistor (A1R34) used to supply base current to driver transistor (A1Q22). Use of this regulated voltage assures minimum changes in regulated output voltage across output capacitor (A1C15), as the AC input voltage to bias transformer (T2) is varied.

3.2.4 VOLTAGE AMPLIFIER:

The voltage feedback amplifier consists of two stages of balanced amplification, assuring minimum sensitivity to fluctuations in ambient temperature or operating voltages. The input signal for the amplifier is derived from a sensing voltage divider connected across the output of the supply.

The output voltage divider consists of fixed resistor (A1R60), VOLTAGE RANGE ADJUST adjustable resistor (A1R59) in the amplifier circuit board, and VOLTAGE ADJUST potentiometer (R9) on the front panel. The negative end of this divider is connected to the negative sensing terminal, and the resistance setting of variable resistor (R9) determines the operating value of the DC output voltage of the supply in a manner which will be explained below.

The positive end of the sensing voltage divider (positive end of resistor (A1R59) is returned to the positive output of the supply through zener diode (A1CR21), the positive bus terminal of the amplifier, and the positive sensing lead. The diode, in conjunction with its load resistor (A1R58), provides a highly stable potential of + 6.2 Volts DC for use as a comparison voltage by the input stage (A1Q19) of the feedback amplifier. When the output of the power supply (measured at the load) is precisely at its selected normal value, the voltage at the right hand base of transistor (A1Q19) (derived from the sensing voltage divider) is at the same level as the left hand base of transistor (A1Q19), and the input stage is in balance. Under this condition, any tendency of the load voltage to vary in either direction will unbalance the amplifier, resulting in corrective action which compensates for the change, and holds the load voltage at its established value, as explained below.

Transistor (A1Q19) is a dual NPN type unit, operated in common-emitter mode, and connected as a balanced differential amplifier. Its outputs, taken across load resistors (A1R56) and (A1R57) are direct-coupled to the bases of the succeeding differential amplifier stage (A1Q17-A1Q18), which consists of two PNP transistors operated in common-emitter mode. The output of (A1Q17), from its load resistor (A1R51), is tied directly to the base of the first driver transistor (A1Q8), which is emitter-follower coupled to second driver transistor (A4Q4).

The sequence of corrective action around the feedback loop is as follows: The left hand input to transistor (A1Q19) is the zero reference level (in this case the voltage at the positive terminal of the load). The right hand input to transistor (A1Q19) is given by the divider action of the resistor string (A1R59), (A1R60) and (R9) connected between the negative sensing point and the amplifier reference voltage at the positive end of (A1CR21). The divider feed point is the junction of (A1R60 and R9) and is tied to the input base through decoupling resistor (A1R53).

The action of the high-gain negative feedback loop is such that the bases of input stage are brought into balance. In other words, the output voltage automatically obtains a value which will cause the voltage at the right hand base of (A1Q19) to balance that of the left hand base of (A1Q19). When the load voltage tends to deviate from the selected value in either direction, due to a change in load current or in input line voltage, this causes the voltage on the sensing divider to shift from its balanced level and the difference (or "error") voltage unbalances the amplifier stage (A1Q19). This difference appears in amplified form in the output of this stage, and is further amplified by the subsequent amplifier stage before being applied to the driver transistors (A1Q8 and A4Q4). The output of the driver transistor causes the regulating transistor assembly to increase or decrease its conductivity in accordance with the error signal so that its overall emitter-collector voltage drop absorbs the variation in load voltage, maintaining an essentially constant value of voltage across the load terminals.

Capacitors (A1C23) and (A1C35) assist the amplifier in responding to rapid changes in load voltage by bypassing a portion of the sensing circuit. The more rapid the change, the greater is the initial transfer to voltage direct to the input of the amplifier, enabling it to detect any radical load variation before the excursion becomes significant.

Diodes (A1CR22 and A1CR23) suppress transients exceeding 0.7V which may reach the bases of differential amplifier (A1Q19).

The sensitivity and speed of response of the corrective feedback circuit is such that the above-described action occurs almost instantaneously, and the actual excursion of the load voltage is held to a very small value. The circuit is a true proportional regulator, and must allow a small but finite "error" to exist between the required and actual regulated voltage, so that this error, however small, can generate the correction signal.

When resistor (R9) is readjusted to produce a different value of output voltage, the circuit makes a correction similar to that described above. Altering the resistance in the sensing voltage divider unbalances the input stage of the feedback amplifier, which then causes the circuit to produce a new value of voltage such that the input bases return to their balanced condition.

3.2.5 CURRENT AMPLIFIER:

The current feedback amplifier consists of two stages of balanced amplification and an emitter follower. An input signal to the amplifier is derived from a sensing voltage divider connected across the sensing resistor (A5R1). The negative end of the divider (negative end of resistor (A1R43) is returned to the positive bus terminal of the supply thru zener diode (A1CR20). This zener diode, in conjunction with its load resistor (A1R37), provides a highly stable potential of -6.2 Volts DC

for use as a comparison voltage by the input stage (A1Q15) of the feedback amplifier. The left hand base of (A1Q15) is fixed, and is at the same potential as the positive output of the supply. The right hand base voltage of (A1Q15) is established by the voltage drop across the sensing resistor (A5R1) and (R8). As the load current thru (A5R1) increases to a value proportional to that selected by the CURRENT ADJUST potentiometer (R8), the right hand base voltage at (A1Q15) attains the same level as the left hand base of (A1Q15), and the input stage is in balance. Under this condition any tendency for the load current to increase will unbalance the amplifier, resulting in corrective action which compensates for any load change and holds the supply current at its established value, as explained below.

With no load on the supply, (A1Q13) is normally conducting thru (A1CR19) and the base of emitter follower (A1Q7) is approximately +0.5 VDC. As the load current is increased so that the drop across the sensing resistor is proportional to that value selected by the CURRENT ADJUST potentiometer (R8), the right hand base of (A1Q15) balances the left hand base of (A1Q15). The base of (A1Q14) is direct-coupled from the right hand collector of (A1Q15) and as the right hand side of (A1Q15) conducts, so does (A1Q14) conduct and decouple diode (A1CR19). This decoupling of (A1CR19) in turn causes (A1Q13) to adjust its current flow since the collector voltage is being driven to the negative voltage of the -12 Volt bias. The negative voltage on the collector of (A1Q13) is direct coupled to the base of the emitter follower (A1Q7), causing (A1Q7) to conduct and (A1CR24) to conduct. Prior to conduction (A1CR24) effectively decouples the current regulating preamplifier from the main amplifier. However, upon conduction (A1CR24) diverts a portion of the current flowing thru voltage divider (A1R59) and (A1R60) thereby causing the voltage amplifier to establish a corrected level of output voltage. The circuitry described is often referred to as "Automatic Cross-Over".

Because of the diverting action of diode (A1CR24), both the voltage amplifier and current amplifier are operating when the supply is in the current mode. Thus, in the region in which load current magnitude is lower than that of the CURRENT ADJUST setting, the diode decouples the current regulator and the power supply is in the voltage regulating mode. In the region in which load current magnitude has achieved a value equal to the CURRENT ADJUST setting, the diode decouples the current regulator and the power supply is in the voltage regulating mode. In the region in which load current magnitude has achieved a value equal to the CURRENT ADJUST setting, the diode conducts and diverts a portion of the feedback current from the voltage amplifier. The power supply is now in the current regulating mode, and the output voltage is adjusted to a lower level depending upon the current diverted by (A1CR24).

3.2.6 These units are furnished with both Voltage Mode and Current Mode Circuitry to indicate the point of "crossover". This circuitry consists of (A1Q5), (A1Q6), (DS3), (DS4) and load resistor (A1R23). At a no load condition (A1Q5) is conducting and VOLTAGE MODE lamp (DS3) is lit. Upon the application of a load, and when the load current attains a value proportional to the current set by the CURRENT ADJUST divider string, the voltage at the left hand base of (A1Q15) approaches the voltage at the right hand base of (A1Q15). At the moment of voltage balance at the bases, (A1Q13) and (A1Q14) switch, (A1Q5) cuts-off and the current flow from (A1CR19) to the base of (A1Q6) causes (A1Q6) to conduct, thereby lighting CURRENT MODE lamp (DS2).

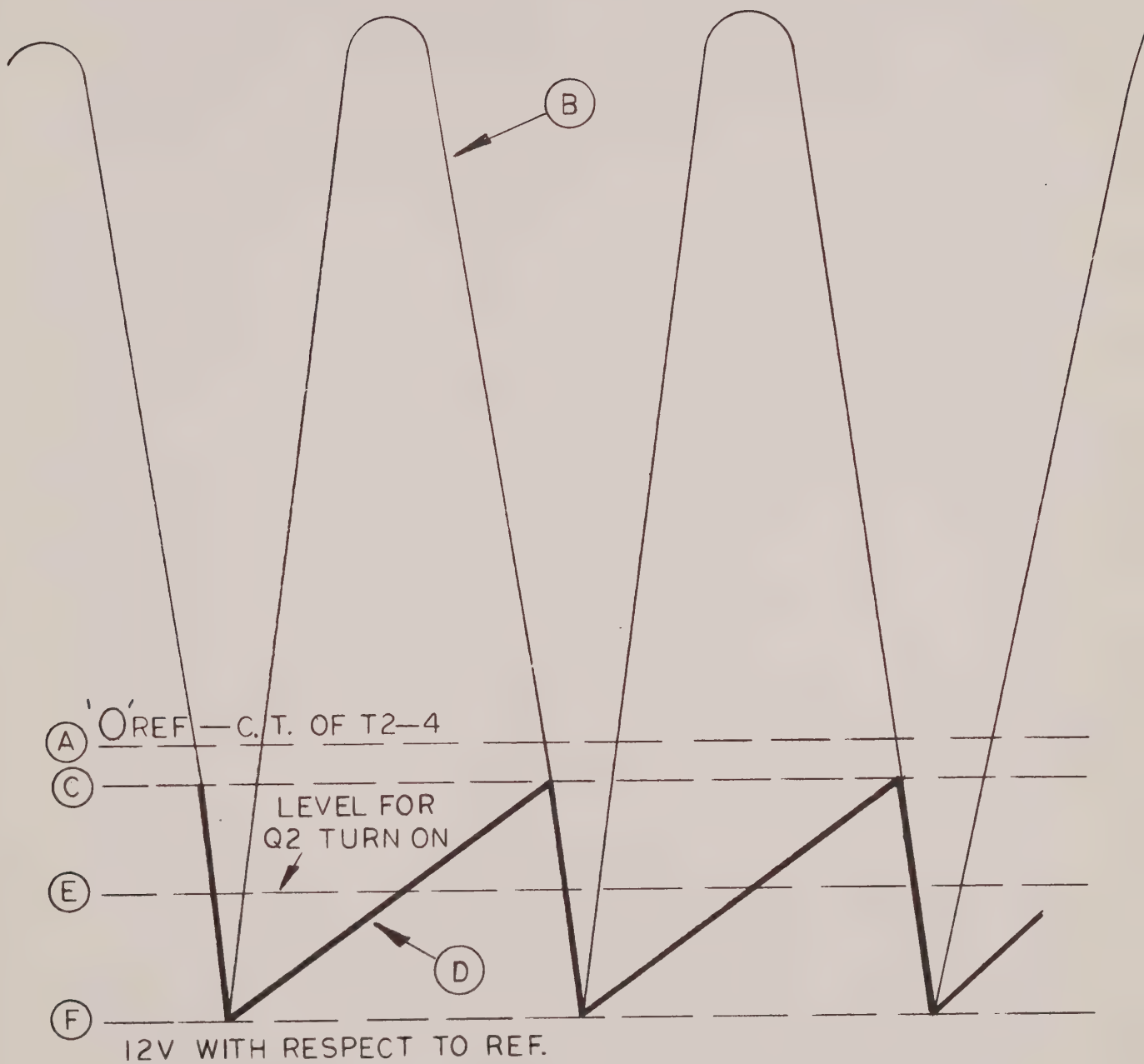


FIG.3-2

WAVEFORMS CROSS REFERENCED
 WITH VOLTAGE LEVELS
 AT NO LOAD

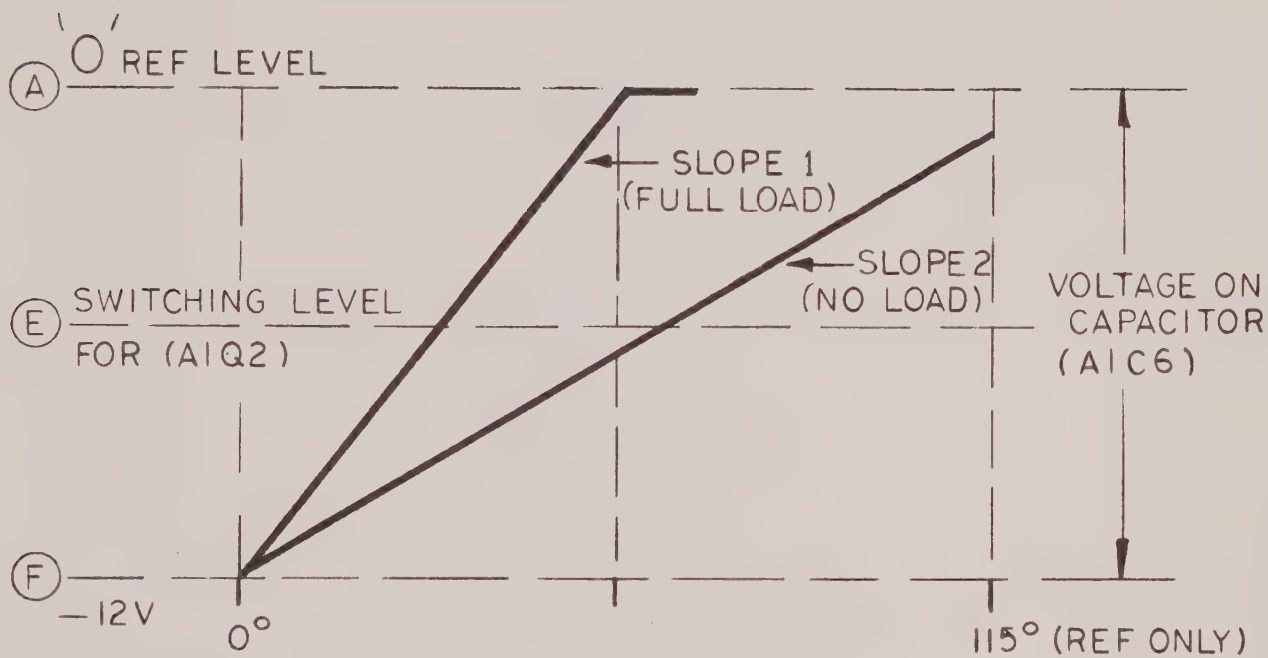


FIG. 3-3

DISCHARGING SLOPE OF TIME BASE CAPACITOR

SECTION IV
MAINTENANCE

- 4.1 GENERAL: Reference drawings for this power supply are provided in Section V. The exact Schematic Drawing is shown in Figure 5-1. Physical location of components is indicated in the Parts Placement Drawings of Section V.

This supply is designed for stable operation over long periods of time. However, if trouble develops, standard test equipment normally found in the Electronics Laboratory would be required. If the customer decides to do complete servicing on his premises, one or more of the following pieces of test instruments are required.

Instrument	Range	Remarks
DC Differential Voltmeter	0-500V	Precise Regulation Check
Oscilloscope	General Purpose	General Troubleshooting
A. C. R.M.S. Voltmeter	General Purpose	Ripple Measurements
Multimeter (Ohmmeter)		General Troubleshooting
A. C. Voltmeter (Precision)	0-150 V	A. C. Input Voltage Checks
D. C. Voltmeter (Precision)	0-25V	D. C. Input Voltage Checks
Variable Autotransformer	Per input Rating	General Troubleshooting
Dummy Loads	As Required	
Source of D. C. Voltage with Low Ripple content. (Batteries preferred).	17-24V. 40A Max.	Input Voltage required for D. C. operation.
4-terminal Sensing Resistor	0.05 Ω , 500W.	Current Regulation and Ripple Measurements

WARNING!!
=====

THE POWER SUPPLY SHALL BE DE-ENERGIZED
WHENEVER ANY COMPONENTS ARE REPLACED!

- 4.2 PREVENTATIVE MAINTENANCE: The principal item that will require attention is the cooling arrangement. All supplies depend upon convection and conduction cooling for proper operation. This supply is equipped with an internal blower and depends upon forced air cooling for proper operation in addition to conduction and convection cooling. Cooling efficiency will be reduced when the supplies are operated in a dust-laden environment, and it is therefore recommended that the supplies be periodically cleaned in order to maintain proper operation.

CAUTION !!

VACUUM CLEANER MAY LOOSEN THE SMALL PLUG-
IN TRANSISTORS!

- 4.3 PROCEDURE FOR OILING THE ROTRON MUFFIN FAN: The fan may require oil if operated under extreme environmental conditions. The fan incorporates the latest electrical and mechanical advances in the motor design and offers reliable performance for 2 to 5 years under favorable conditions of temperature and vibration without the necessity of oiling. Its life is in inverse proportion to these factors. For example, at 110°F the fan may be expected to give reliable performance in excess of three years and at 40°F reliable performance is extended beyond five years.

If the power supply should be installed in areas of greater heat, or severe vibration, the life of the fan may be extended by periodic oiling (a small amount once per year) which is absorbed by the bearing. For this oiling procedure, an OIL INJECTOR NJE Part No. 021988 is required and may be ordered from NJE Corporation. This OIL INJECTOR will service from 15 to 20 fans. For refills order Fan Lubricant NJE Part No. 020923 in 4 oz. can.

Procedure:

- Step 1: Remove cap from end of OIL INJECTOR.
- Step 2: Place needle at the center of circle marked on the Gold Label.
- Step 3: Position the needle at an angle of approximately 45° to the surface of the label and tangent to the perimeter of the circle.
- Step 4: Pierce the label and the concealed self-sealing rubber cap located under the label.
- Step 5: Insert the needle approximately 1/4".
- Step 6: Depress the plunger of the OIL INJECTOR slowly to the next calibration mark which will allow 1/16" of oil to escape.

NOTE: It is better to give a little more oil than not enough. However, do not overflow the well. If the ambient temperatures are extremely hot, it may be advisable to oil more frequently to insure the optimum performance characteristics of the fan.

4.4 MEASUREMENTS AND TESTS:

- 4.4.1 Sensing Connection - Constant Voltage Mode: Sensing lead connections are of utmost importance in making proper regulation measurements. It is recommended that the sensing connections be made directly at the output terminal points rather than at a remote load point. Although the regulation measurement should check correctly at a remote point as well as at the supply terminals, it is well to ascertain that the power supply itself is operating without introducing the possibility of extraneous external wiring problems. Thus, all measurements should be made with "local" sensing connections, i.e., with the Sensing Terminals jumpered directly to the corresponding Output Terminals. One other point of caution in proper measurement technique is the following:

It is absolutely essential that the measuring equipment connections be made directly to the sensing terminals, whereas the load lead connections must be made directly to the Output Terminals. Figure 4-1 shows proper and improper connections for measurements taken with "local" and "remote sensing" connections.

- 4.4.2 Sensing Connection - Constant Current Mode: Sensing lead connections must be made directly at the measuring terminal points of the four-terminal current sensing resistor.

It is absolutely essential that the measuring equipment connections be made directly to the measurement terminals, whereas the load lead connections must be made directly to the power terminals. Figure 4-3 shows proper connections for measurements.

Various measurements can be made using essentially the same connections, but using different instrumentation. The following paragraphs describe the basic parameters which may be tested.

- 4.4.3 Regulation Checks: Since regulation of these power supplies is as low as 0.05%, special measuring techniques must be employed to accurately check the various regulation parameters. It is necessary to use an external source of DC voltage of approximately the same value as the power supply output or current sensing resistor voltage drop as a "bucking" source, connected as shown in Figure 4-2 or 4-3. This DC bucking voltage can be either an electronic, null balance differential voltmeter, or a group of batteries connected in series (or another power supply), furnishing a DC potential slightly larger than the output voltage of the power supply under test. When using a differential voltmeter, the voltmeter is built right into the test equipment. When a "bucking" battery is used the voltmeter should have a full-scale range low enough to detect the magnitude of regulation expected.

A multi-tester used on the 1-volt range will usually be adequate, since approximately 10 millivolts can be observed reasonably well. The point here is that the voltmeter is used to measure only the difference between two almost equal voltages. The balance adjustment (either in the electronic unit, or the test set-up of the diagram) is used to bring the meter needle to approximately midscale before testing, so that the deviation above or below the normal output of the supply under test can be observed.

- 4.4.4 Static Load Regulation - Constant Voltage Mode: The dummy load (R1) of Figure 4-2 is selected to draw full load current at the nominal output voltage of the supply. The difference between the differential voltmeter readings with the switch open and closed (allowing the needle to come to rest before reading), gives the static load regulation in volts. When load changes are made, it may be necessary to readjust the line voltage to its nominal value.
- 4.4.5 Static Load Regulation - Constant Current Mode: The dummy load (R1) of Figure 4-3 is selected to draw minimum load current at some output voltage of the supply. The difference between the differential voltmeter readings with the switch open and closed (allowing the needle to come to rest before reading), gives the static load regulation in volts. When load changes are made, it may be necessary to readjust the line voltage to its nominal value. (The load regulation value in volts should be divided by the value of the 4-terminal sensing resistor to convert the readings to current regulation values.)
- 4.4.6 Static Line Regulation: With the load set at some fixed value, either no load, full load, or some in-between point, the input line is varied by means of the variable auto transformer shown in Figure 4-2 or Figure 4-3. Note that if this measurement is made under a heavy load condition, the auto-transformer must be selected to supply the necessary input volt-amperes. The difference between the differential voltmeter reading for different line voltage conditions (allowing the needle to come to rest before reading), gives the static line regulation in volts. (The load regulation value in volts should be divided by the value of the 4-terminal sensing resistor to convert the readings to current when measuring current regulation.)
- 4.4.7 Ripple - Constant Voltage Mode: A sensitive true RMS voltmeter should be connected directly across the power supply sensing terminals for this measurement. The same set-up as used for the regulation checks may be used if it is desired to observe the ripple under different conditions of the voltage and load current. Be sure to make the measurement connections at the sensing terminals rather than at the load terminals.
- 4.4.8 Ripple - Constant Current Mode: A sensitive true RMS voltmeter should be connected directly across the 4-terminal sensing resistor measuring

terminals for this measurement. The same set-up as used for the regulation checks may be used if it is desired to observe the ripple under different conditions of the voltage and load current. Be sure to make the measurement connections at the sensing resistors measuring terminals rather than at the power terminals. (The ripple value in volts should be divided by the value of the 4-terminal sensing resistor to convert the readings to current ripple values.)

- 4.4.9 Dynamic Regulation and Recovery Time - Constant Voltage Mode Only: In the test set-up described above for Static Load or Line Regulation, a calibrated oscilloscope should be substituted for the differential voltmeter. Maximum deflection and recovery time are measured directly as a dummy load of appropriate value is switched in and out of the circuit. A mercury switch is recommended to minimize arcing, or else an electronic switch should be used. If available, the latter is highly desirable, since the response is readily displayed on the oscilloscope. The rise and fall time of the current step should be at least five times faster than the anticipated recovery time.
- 4.4.10 Stability: A detailed check for improper drift and intermittent failure can be made by utilizing the same test arrangement as for static regulation measurements. The only requirement is that the differential voltmeter used must have a stability of an order of magnitude better than that of the power supply. If available, a stable recorder may be substituted for the differential voltmeter in the drawing, thereby procuring a continuous tracing of the power supply stability.

4.5 TROUBLESHOOTING:

There are various types of trouble possible with this supply. The following procedure diagnoses the most likely types of trouble.

CAUTION: The Output Sensing Terminals must always be cross-connected to the output voltage terminals. Failure to observe this rule will result in catastrophic failure of the power supply!!!

NO OUTPUT:

SYMPTOM	POSSIBLE CAUSE	REMARKS
Fuse blown	Shorted component	Check the unregulated DC sources (main and aux) and localize trouble.
Fuse not blown	Defective transistor or component in trigger amplifier.	Check if SCR has been turned off by trigger amp. (A1Q1)

LOW VOLTAGE OUT:

SYMPTOM	POSSIBLE CAUSE	REMARKS
Voltage moveable	Defective reference diode	Perform stability tests on Paragraph 4.8.
Voltage stable	Defective component on PC subassembly	Check if SCR has been partially "turned on" by trigger amp. Check storage voltage across series pass transistors and if high, check error amp.

HIGH VOLTAGE OUT:

SYMPTOM	POSSIBLE CAUSE	REMARKS
Constantly high voltage	Defective component on PC subassembly	Check if SCR has been permanently "turned on" by trigger amp. Check storage voltage across series pass transistors. If low, check error amp.

NO REGULATION:

SYMPTOM	POSSIBLE CAUSE	REMARKS
Do not operate unit until the sensing terminals are checked for proper connections.		

POOR REGULATION:

SYMPTOM	POSSIBLE CAUSE	REMARKS
Regulation poor under load or line changes	Defective transistor or component on PC subassembly	

4.6 ALIGNMENT AND ADJUSTMENT:

The power supply has several controls that are factory adjusted and normally do not require attention in the field. If any of the components in the error-difference amplifier are replaced or the ammeter requires calibration, the following readjustment procedure may be necessary.

4.6.1 VOLTAGE ADJUST CALIBRATION:

- Step 1: Set OUTPUT ADJUST variable resistor (R9) completely clockwise. The unit may be operated at nominal line and at no load.
- Step 2: Place calibrated voltmeter across output.
- Step 3: Adjust variable resistor (A1R59) until full rated output is reached.

4.6.2 CURRENT ADJUST CALIBRATION:

Step 1: Set OUTPUT VOLTAGE ADJUST variable resistor (R9) completely clockwise.

NOTE: Verify that the output is the full rated voltage.

Step 2: Set CURRENT ADJUST variable resistor (R8) completely clockwise.

Step 3: Short circuit output through a calibrated ammeter.

Step 4: Slowly rotate variable resistor (A1R43) until current level reaches rated value.

4.6.3 AMMETER CALIBRATION:

Step 1: Set OUTPUT ADJUST variable resistor (R9) completely clockwise.

Step 2: Set CURRENT ADJUST variable resistor (R8) completely clockwise.

Step 3: Short circuit output through a calibrated ammeter.

Step 4: Adjust AMMETER CALIBRATION ADJUST until unit meter agrees with external calibration meter.

4.7 ERROR-DIFFERENTIAL AND SECONDARY REGULATION AMPLIFIER CHECK:

There are several methods which can be used in checking the performance and condition of these amplifiers.

Except for individually removing the transistors for a check by means of a transistor test set, and making continuity and resistance tests on the circuit and components, all methods require the amplifier to be energized with the proper potentials under the conditions found in the power supply for normal operation. For this reason, it is simplest to test the amplifier in position in the supply, first making certain that the unregulated DC bias sources are functioning properly. Once this is done, the procedure given below can be used to check out the amplifiers.

4.7.1 SIGNAL TRACING CHECK:

Since there is an inherent amount of ripple at the input of the amplifiers, this ripple signal can be used as a test signal for observing the amplifier performance with the aid of a test oscilloscope. (Ignore any spikes in the waveform). Use only the basic ripple signal when making amplitude calculations. In the event that

the ripple is too small for practical use, a small 60-cycle sine wave voltage of convenient amplitude (less than 0.1 volt) can be injected into the amplifier by applying it to the base of the input transistor (A1Q19) on the printed circuit board. Measurement of the ripple at the input to the amplifier, and at the output of each successive amplifier stage will provide an effective check of amplifier performance. The ripple amplitude measured at the base (or input) of the second stage transistors (A1Q17) and (A1Q18) should be 40 to 100 times the amplitude at the input to the first stage. Radical departure from this set of conditions will be inspection and individual test. Be sure not to overdrive the amplifier stages as it will cause misleading results. This process can be continued until the emitter follower stages are reached. At this point the circuitry undergoes an impedance transformation and no voltage gain will be noted. Instead, a decrease in amplitude will be noted.

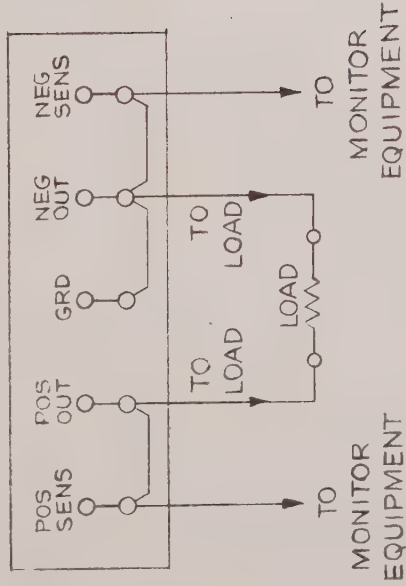
4.8 STABILITY CHECK:

A detailed check for improper drift and intermittent failure can be made by utilizing a test arrangement similar to that shown for regulation check in Figure 4-2 or 4-3.

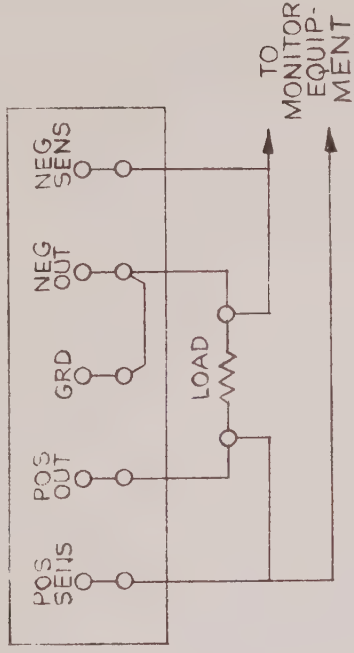
NOTE: Observe polarity of set-up as required.

The voltage across the breakdown diode reference sources may be "bucked out" and monitored by an 0 to 10 millivolt (or smaller scale, if available) high impedance DC voltage (null balance voltmeter). Drift or random instability will be readily visible in this test. Output voltages of the successive amplifier stages can then be monitored in the same manner. When checking a given amplifier stage by this method the output of the previous stage should be shorted, to prevent external voltage variations from reaching the stage under test. This does not include shorting the output terminals of the power supply. Care must be exercised to guard the load circuit from extraneous fields. When installing a new transistor in place of one shown to be defective, the stability check should be repeated to make certain that the trouble has been eliminated.

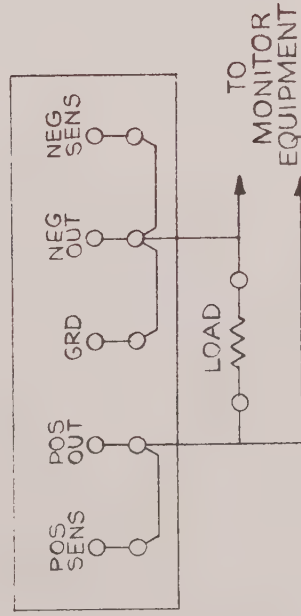
CORRECT



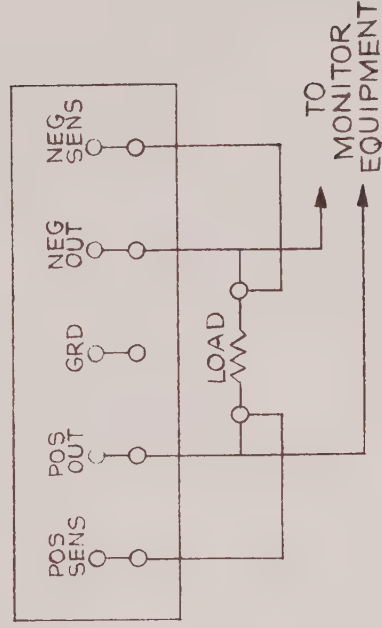
CORRECT



INCORRECT



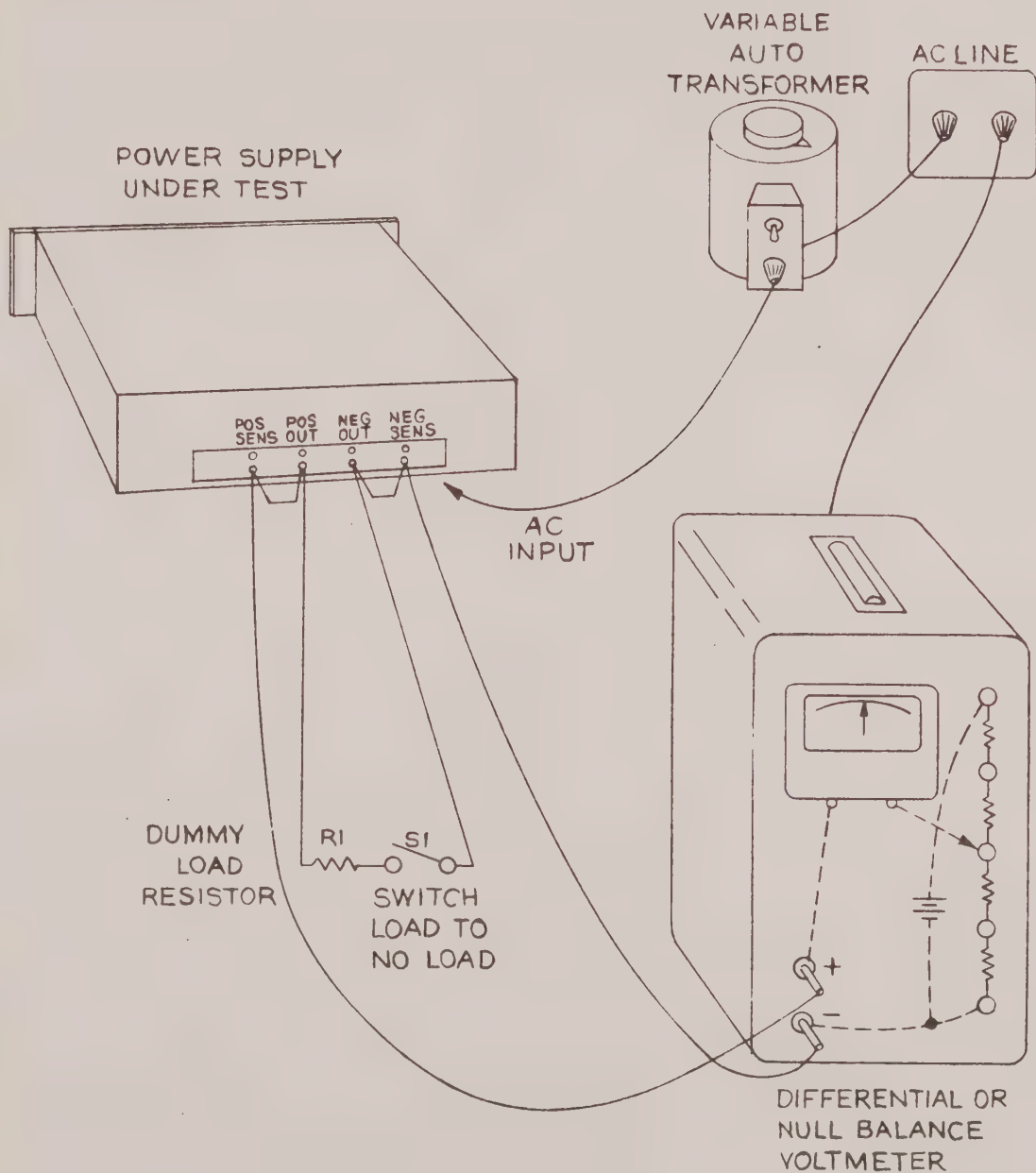
INCORRECT



LOCAL SENSING

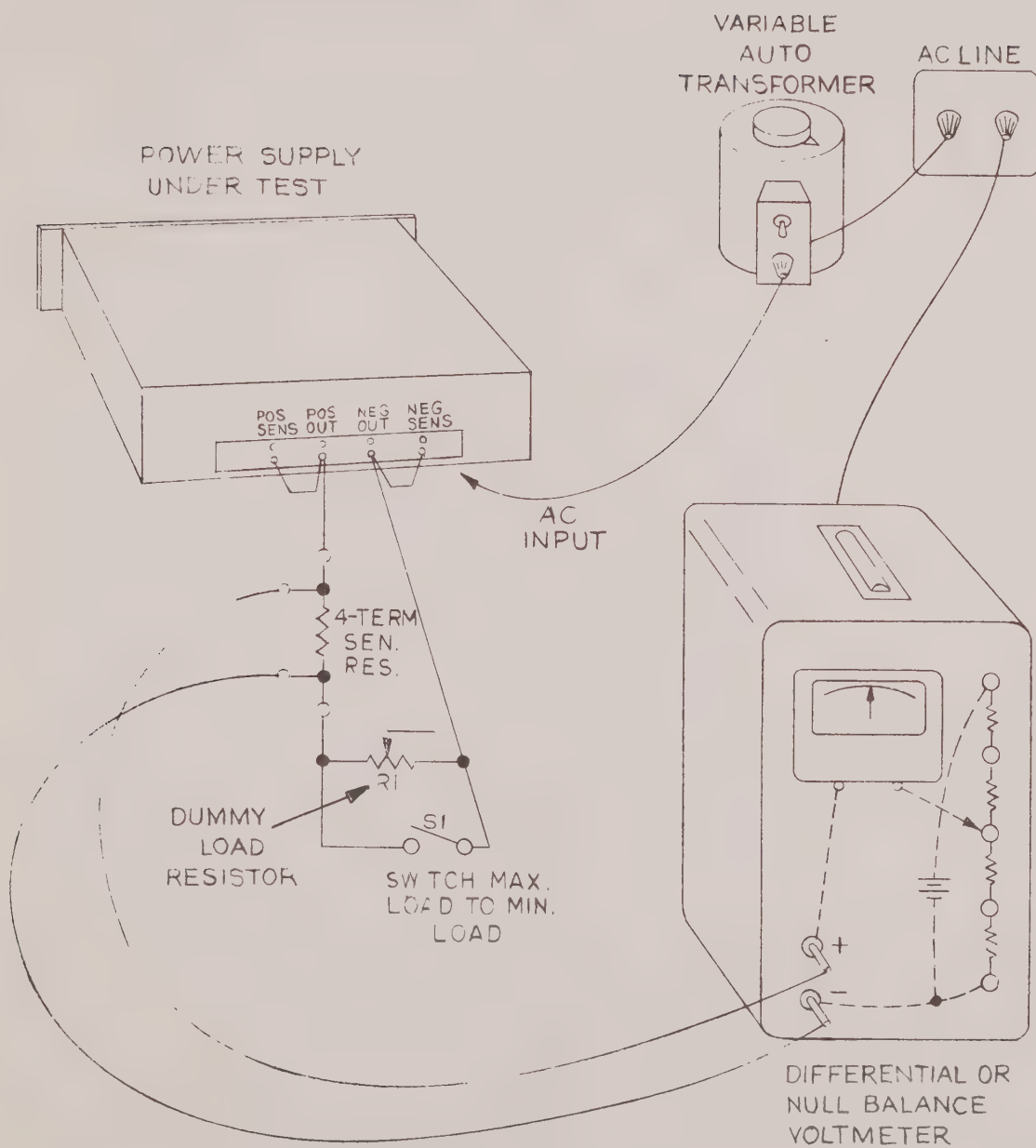
REMOTE SENSING

MEASUREMENT CONNECTIONS WITH LOCAL SENSING AND REMOTE SENSING



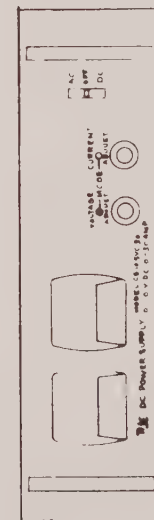
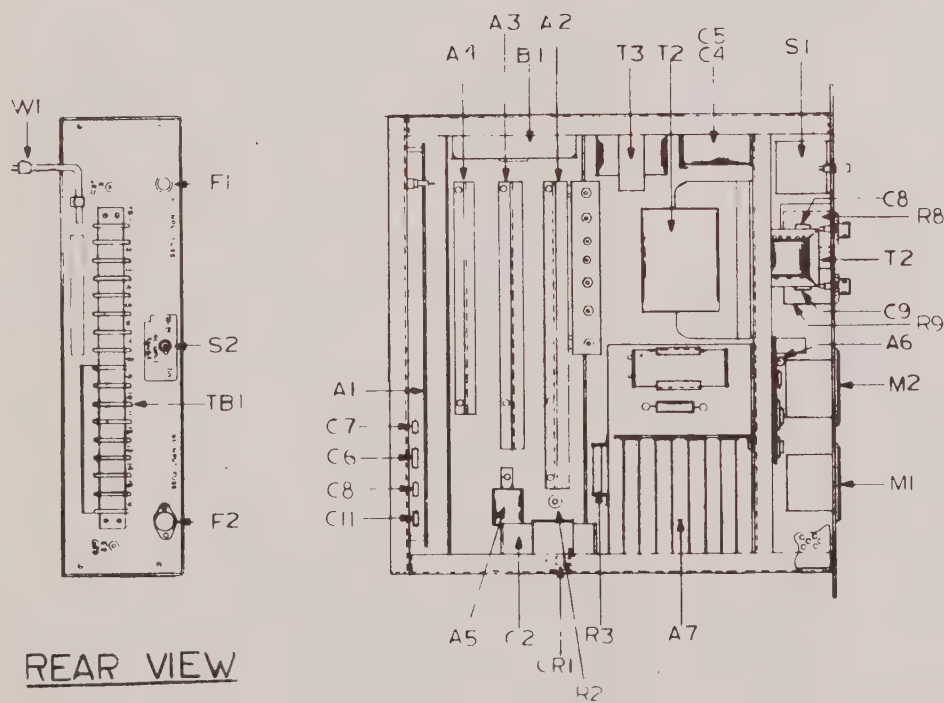
REGULATION CHECK
TYPICAL LAYOUT

FIG. 4-2



REGULATION CHECK
TYPICAL LAYOUT

FIG. 4-3



REAR VIEW

FRONT VIEW

TOP VIEW

PART PLACEMENT

N J E CORPORATION
 KENILWORTH, N. J.

SIZE
A

CODE IDENT NO.
98380

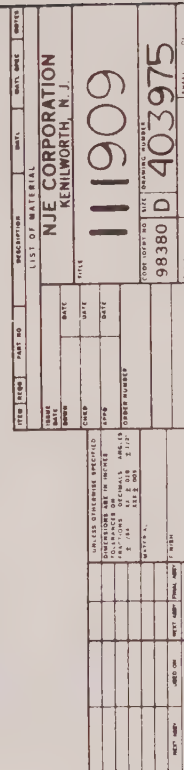
DWG NO.

111838

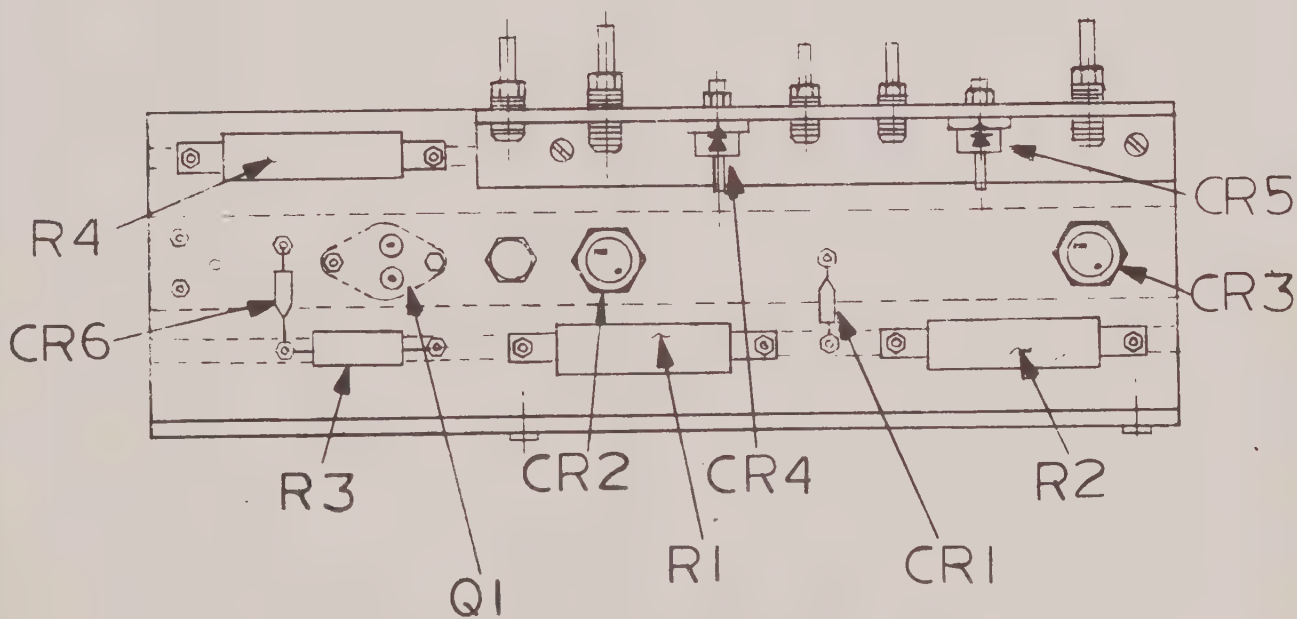
SCALE

REV

SHEET



PART PLACEMENT-AI



PART PLACEMENT A2

N J E CORPORATION
KENILWORTH, N. J.

SIZE
A

CODE IDENT NO.
98380

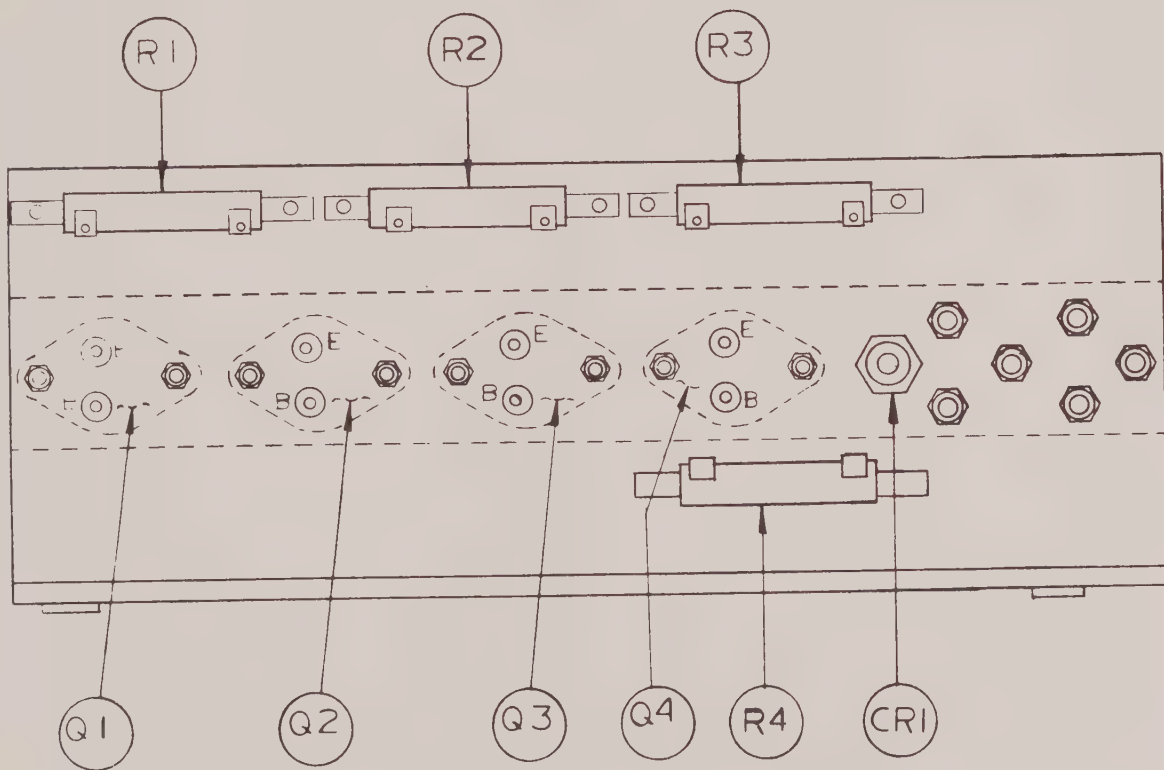
DWG NO.

111361

SCALE NONE

REV

SHEET **2**



PART PLACEMENT-A3

N J E CORPORATION
KENILWORTH, N. J.

SIZE

A

CODE IDENT NO.

98380

DWG NO.

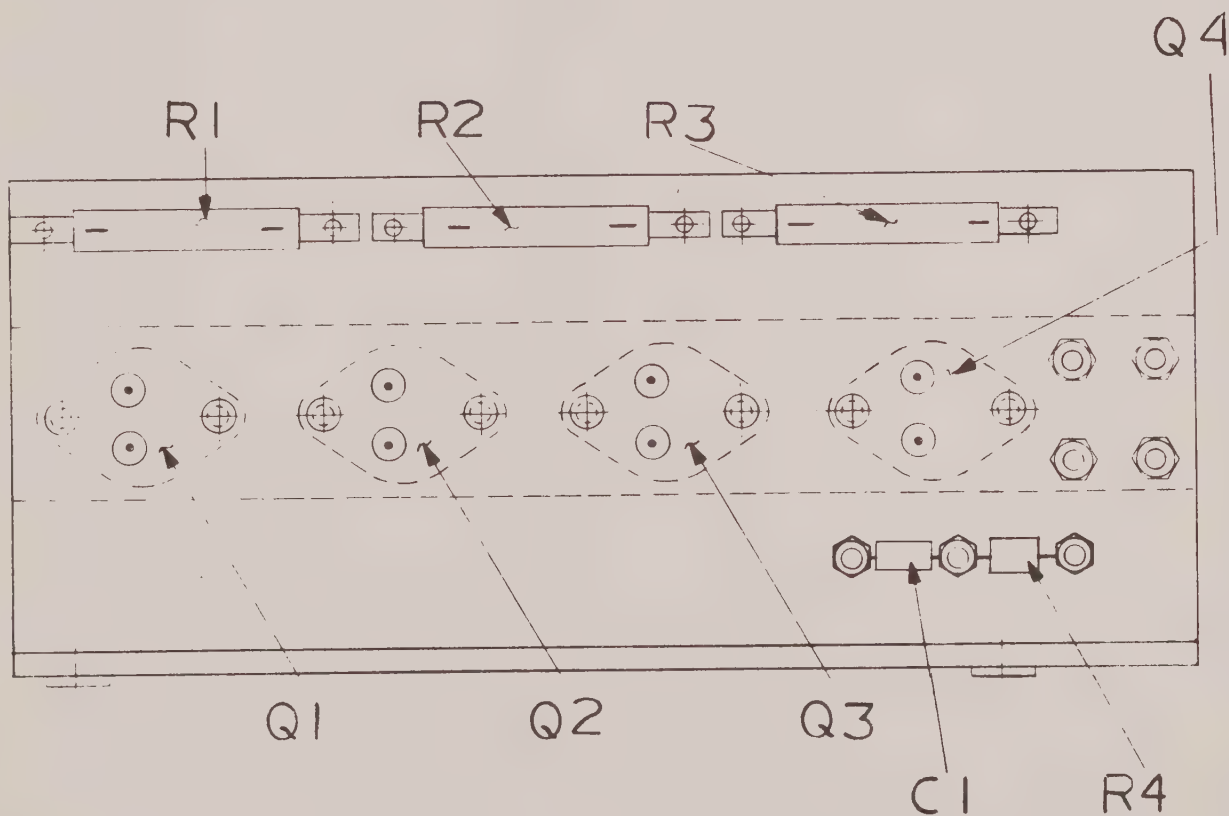
111835

SCALE

REV

SHEET

2



PART PLACEMENT-A4

N J E CORPORATION
KENILWORTH, N. J.

SIZE
A

CODE IDENT NO.
98380

DWG NO.

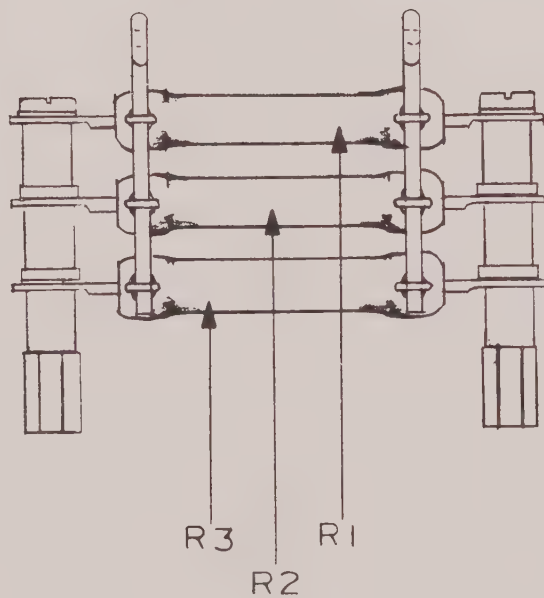
11362

SCALE

REV

SHEET

2



PART PLACEMENT-A5

N J E CORPORATION
KENILWORTH, N. J.

SIZE
A

CODE IDENT NO.
98380

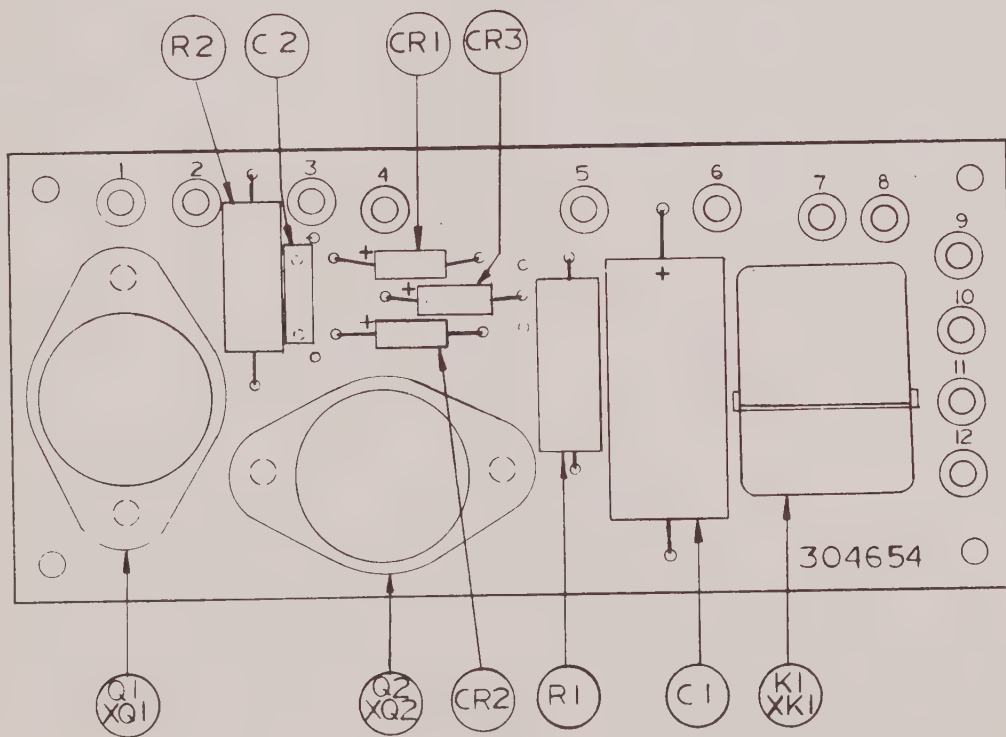
DWG NO.

11183E

SCALE

REV

SHEET 2



PART PLACEMENT-A6

N J E CORPORATION
KENILWORTH, N. J.

SIZE
A

CODE IDENT NO.
98380

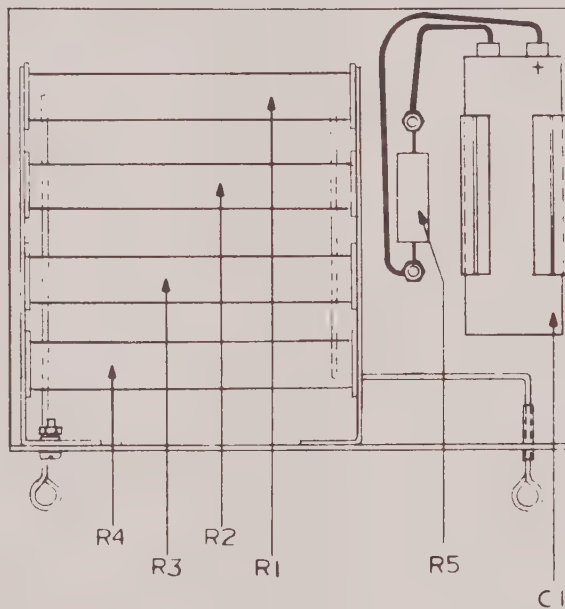
DWG NO.

111834

SCALE

REV

SHEET



PART PLACEMENT-A 7

N J E CORPORATION
KENILWORTH, N. J.

SIZE
A

CODE IDENT NO.
98380

DWG NO.

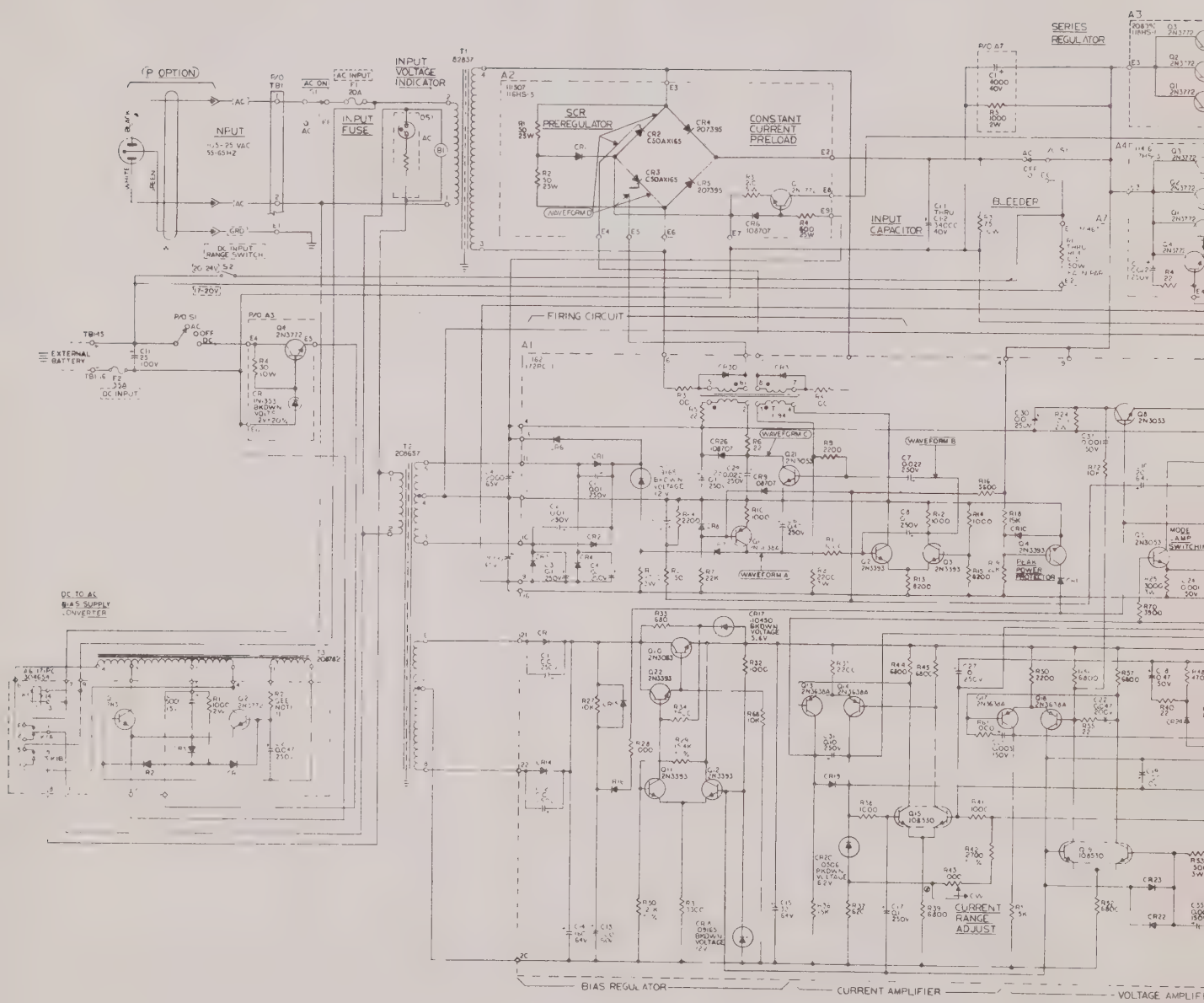
111837

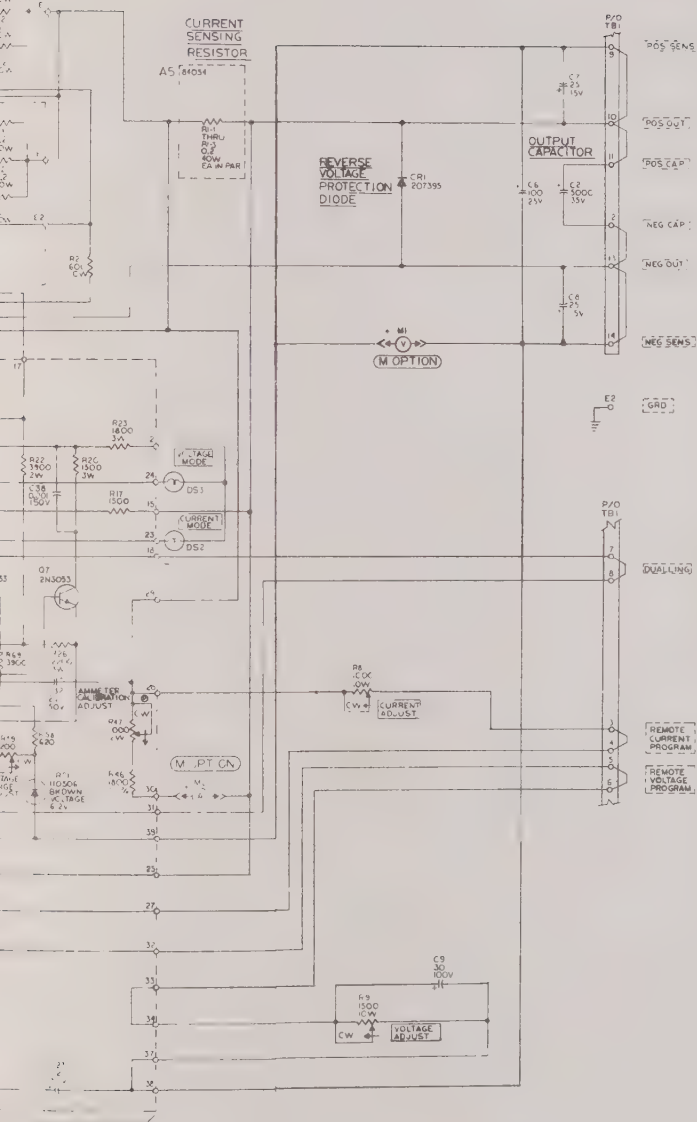
SCALE NONE

REV

SHEET

2



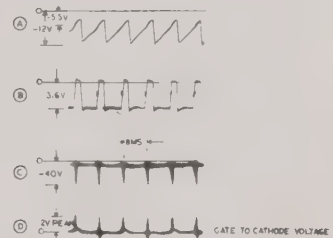


OUTPUT
0-10VDC
0-30A

REF	DESCRIPTION	DATE	BY
1	REVISION		
2	REVISION		
3	REVISION		
4	REVISION		
5	REVISION		
6	REVISION		
7	REVISION		
8	REVISION		
9	REVISION		
10	REVISION		

NOTES

- ALL RESISTORS 0.5W UNLESS OTHERWISE SPECIFIED
- ALL CAPACITORS IN MFD UNLESS OTHERWISE SPECIFIED
- ALL DIODES ARE 102539 UNLESS OTHERWISE SPECIFIED
- BOTTOM VIEW OF TRANSISTORS FOR A1 (Q15-Q19)
 
- TOP VIEW OF TRANSISTOR SOCKETS FOR A1 (Q15-Q19)
 
- BOTTOM VIEW OF TRANSISTORS A1 (Q1-Q14) Q11-Q12 ONLY
 
- TOP VIEW OF TRANSISTOR SOCKETS EXCEPT FOR A1 (Q15-Q19)
 
- AMMETER M2 IS 0.1 MA MOVEMENT
- ALL VOLTAGES MEASURED WITH RESPECT TO POSITIVE OUTPUT TERMINALS INPUT TO SUPPLY (15 VAC 60 CPS 1PH) OUTPUT VOLTAGE OF SUPPLY MIN VALUE WITH NO LOAD ON TYPE OUTPUT TERMINALS
- WAVEFORM (CONDITIONS SAME AS NOTE 9)



- A5 RZ VALUE SELECTED IN TEST FOR OPTIMUM PERFORMANCE OF CONVERTER.

REF 140394

ITEM CLASS NO.	MODEL	DATE	BY
CS 10 SVC 30			
SCHEMATIC			
70474			

ABBREVIATIONS USED IN SPARE PARTS LIST

In DESCRIPTION Column: "SA" is used to mean "Same As" and "PO" is used to mean "Part Of". Where these symbols are used, the UNIT QTY., SPARE QTY., UNIT PRICE and NJE PART NO., columns are all blank.

In VALUE Column: The use of the letter "R" to indicate a decimal point is illustrated by the following examples: 5.6 Ω is written as 5R60K. 1/2 watts is written as R500 W. The use of zeroes does not imply a precision to the indicated number of decimal places but is a requirement of the proper handling of the Data Processing Cards from which these spare parts lists are written.

The standard symbols for electrical units are used and usually appear in the columns immediately to the left of the dashed and solid lines in the Value field. In all cases, the symbol " Ω " is not printed for resistors and is understood. For example: 200 Ω is written 200 and 2.7M Ω is written 2R70M.

In REFERENCE DESIGNATION Column: The reference designations are those which interrelate the Spare Parts List, the Schematic Diagrams and the Parts Placement drawings. The symbols are those of MIL-STD-16. Where the reference designation is an "A" (meaning a sub-assembly), a Spare Parts List bearing the NJE Part Number of that assembly is included in the Spare Parts List section.

Deviations: Where minor deviations are accomplished by modifying a standard unit, a Spare Parts List which only shows the deletions and additions from the enclosed standard Spare Parts List is used.

MODEL CS-10SVC30

701496 PAGE NO. 1 of 2
REV.

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
A1	CKT CARD ASSY.	172PC-1		111621	1	1	
A2	HEAT SINK	116HS-5		111507	1	1	
A3	HEAT SINK	118HS-1		208992	1	1	
A4	HEAT SINK	117HS-3		111416	1	1	
A5	RESISTOR ASSY	RESISTOR ASSY		84054	1	1	
A6	CKT CARD ASSY	171PC-1		304654	1	1	
A7	RESISTOR ASSY	RESISTOR ASSY		304671	1	1	
B1	BLOWER 60Hz	115V	1PH	2	1	1	18.00
C1-1	CAP, FXD ELECT	34,000 μ F	40V	109183	2	1	34.00
C1-2	SAME AS C1-1						
C2	CAP, FXD ELECT	5000 μ F	35V	109312	1	1	20.60
C3	NOT USED						
C4	CAP, FXD ELECT	2000 μ F	65V	107366	2	1	16.50
C5	SAME AS C4						
C6	CAP, FXD ELECT	100 μ F	25V	106889	1	1	1.50
C7	CAP, FXD ELECT	25 μ F	15V	656	2	1	2.04
C8	SAME AS C7						
C9	CAP, FXD TANT	30 μ F	100V	22	1	1	9.00
C10	NOT USED						
C11	CAP, FXD ELECT	25 μ F	100V	675	1	1	2.20
CR1	DIODE, RECT	35A	200V	207395	1	1	6.00
DS1	INDICATOR, NEON	125V		5644	1	1	4.00
DS2	INDICATOR, INCND	10V	14MA	5643	2	1	4.00
DS3	SAME AS DS2						

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

MODEL CS-10SVC30

701496

PAGE NO. 2

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
F1	FUSE, CARTRIDGE	20A	250V	234	1	5	.25
F2	FUSE, CARTRIDGE	35A	32V	3719	1	5	.25
K1	NOT USED						
M1	METER, VOLT, DC	10V	1 K/V	109117	1	1	26.00
M2	METER, AMP, DC	30A	1MA	110301	1	1	26.00
R1	NOT USED						
R2	RES, FXD WW	600.00	10W	110420	1	1	1.00
R3	RES, FXD WW	75.00	10W	110413	1	1	1.00
R4-1	NOT USED						
R4-2	NOT USED						
R5	NOT USED						
R6	NOT USED						
R7	NOT USED						
R8	RES, VAR WW	1.0K	10W	1947	1	1	20.00
R9	RES, VAR WW	1.5K	10W	114	1	1	20.00
S1	SWITCH, LEVER	30A	125V	111535	1	1	39.95
S2	SWITCH, TOGGLE	SPST	15A	20605	1	1	1.50
T1	TRANSFORMER	TRANSFORMER		82837	1	1	90.00
T2	TRANSFORMER	TRANSFORMER		208657	1	1	24.30
T3	TRANSFORMER	TRANSFORMER		208782	1	1	24.00
TB1	TERMINAL BD.	16 TERM	30A	111612	1	1	7.00
XF1	FUSE HOLDER	30A	250V	20831	1	1	.50
XF2	FUSE HOLDER	30A	250V	212	1	1	1.00
W1	LINE CORD	3 WIRE	15A	111614	1	1	3.50

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

MODEL 172PC-1

111621

PAGE NO. 1 of 8

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
C1	CAP, FXD FOIL	.01 μ F	250V	5483	7	2	1.00
C2	SAME AS C1						
C3	SAME AS C1						
C4	SAME AS C1						
C5	CAP, FXD ELECT	50 μ F	15V	462	1	1	1.75
C6	CAP, FXD FOIL	.47 μ F	250V	5517	1	1	1.75
C7	CAP, FXD FOIL	.022 μ F	250V	5518	2	1	1.00
C8	CAP, FXD FOIL	.10 μ F	250V	5480	4	1	1.00
C9	NOT USED						
C10	CAP, FXD ELECT	20 μ F	64V	5652	1	1	2.00
C11	SAME AS C1						
C12	SAME AS C1						
C13	CAP, FXD TANT	100 μ F	50V	111817	1	1	9.00
C14	CAP, FXD ELECT	160 μ F	64V	5653	1	1	2.50
C15	CAP, FXD ELECT	32 μ F	64V	5654	1	1	2.00
C16	NOT USED						
C17	SAME AS C8						
C18	CAP, FXD CERAM.	.47 μ F	50V	20861	1	1	6.00
C19	CAP, FXD ELECT	200 μ F	10V	654	1	1	3.00
C20	NOT USED						
C21	CAP, FXD CERAM.	3000PF	150V	4	1	1	.50
C22	CAP, FXD FOIL	.047 μ F	200V	5366	1	1	1.00
C23	CAP, FXD TANT	2.2 μ F	50V	20099	2	1	4.00
C24	CAP, FXD CERAM.	1000PF	150V	20819	4	1	1.00

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

MODEL 172PC-1

P/N 111621

PAGE NO. 2

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
C25	NOT USED						
C26	NOT USED						
C27	CAP FXD FOIL	1 μ F	250V	5554	1	1	1.00
C28	SAME AS C8						
C29	SAME AS C7						
C30	SAME AS C1						
C31	SAME AS C8						
C32	SAME AS C23						
C33	NOT USED						
C34	NOT USED						
C35	SAME AS C24						
C36	NOT USED						
C37	SAME AS C24						
C38	SAME AS C24						
CR1	DIODE, RECT	500MA	300V	102539	19	5	1.20
CR2	SAME AS CR1						
CR3	SAME AS CR1						
CR4	SAME AS CR1						
CR5	DIODE, BKDWN	1W	12V	109165	2	2	4.50
CR6	SAME AS CR1						
CR7	SAME AS CR1						
CR8	SAME AS CR1						
CR9	DIODE, BKDWN 10%	30MA	2V	108707	2	2	3.00
CR10	SAME AS CR1						

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

MODEL 172PC-1
P/N 111621
PAGE NO. 3

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
CR11	SAME AS CR1						
CR12	NOT USED						
CR13	SAME AS CR1						
CR14	SAME AS CR1						
CR15	SAME AS CR1						
CR16	SAME AS CR1						
CR17	DIODE, BKDWN 5%	400MW	5.6V	110450	1	1	5.75
CR18	SAME AS CR5						
CR19	SAME AS CR1						
CR20	DIODE, BKDWN5%	400 MW	6.2V	110506	2	2	6.25
CR21	SAME AS CR20						
CR22	SAME AS CR1						
CR23	SAME AS CR1						
CR24	SAME AS CR1						
CR25	NOT USED						
CR26	SAME AS CR9						
CR27	NOT USED						
CR28	NOT USED						
CR29	NOT USED						
CR30	SAME AS CR1						
CR31	SAME AS CR1						
Q1	XISTOR PNP S1	300 MW	25V	5456	5	2	3.00
Q2	XISTOR, NPN S1	200MW	25V	5650	6	2	3.00
Q3	SAME AS Q2						

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

MODEL 172PC-1

P/N 111621

PAGE NO. 4

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
Q4	SAME AS Q2						
Q5	XISTOR, NPN S1	4W	60V	5258	6	2	2.00
Q6	SAME AS Q5						
Q7	SAME AS Q5						
Q8	SAME AS Q5						
Q9	NOT USED						
Q10	SAME AS Q5						
Q11	SAME AS Q2						
Q12	SAME AS Q2						
Q13	SAME AS Q1						
Q14	SAME AS Q1						
Q15	XISTOR, NPN,S1	250MW	50V	108530	2	2	7.00
Q16	NOT USED						
Q17	SAME AS Q1						
Q18	SAME AS Q1						
Q19	SAME AS Q15						
Q20	NOT USED						
Q21	SAME AS Q5						
Q22	SAME AS Q2						
R1	RES FXD W. W	2.70K	3W	1659	1	1	.86
R2	RES FXD COMP	150.00	.500W	111197	1	1	.20
R3	RES FXD COMP	100.00	.500W	21761	2	1	.20
R4	SAME AS R3						
R5	RES FXD COMP	22.00	.500W	111198	4	1	.20

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

MODEL 172PC-1
P/N 111621
PAGE NO. 5

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
R6	SAME AS R5						
R7	RES FXD COMP	22.00K	.500W	1027	2	1	.20
R8	RES FXD W.W	2.20K	3W	1656	2	1	.86
R9	RES FXD COMP	2.20K	.500W	1024	4	1	.20
R10	RES FXD COMP	1.00K	.500W	451	8	2	.20
R11	SAME AS R10						
R12	SAME AS R10						
R13	RES FXD COMP	8.20K	.500W	1026	2	1	.20
R14	SAME AS R10						
R15	SAME AS R13						
R16	RES FXD COMP	5.60K	.500W	472	1	1	.20
R17	RES FXD COMP	1.50K	.500W	1022	1	1	.20
R18	RES FXD COMP	15.00K	.500W	530	3	1	.20
R19	SAME AS R7						
R20	RES FXD W.W	1.50K	3W	5050	2	1	.86
R21	NOT USED						
R22	RES FXD COMP	3.90K	2W	1080	1	1	.18
R23	RES FXD W.W	1.80K	3W	1654	1	1	1.00
R24	RES FXD COMP	1.00K	2W	188	1	1	.36
R25	RES FXD W.W	3.00K	3W	1660	1	1	1.00
R26	SAME AS R8						
R27	RES FXD COMP	10.00K	.500W	475	3	1	.20
R28	SAME AS R10						
R29	RES FXD FILM	15.4K	.5W	110267	1	1	2.50

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

MODEL 172PC-1
P/N 111621
PAGE NO. 6

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
R30	RES FXD FILM	12.1K	.5W	110268	1	1	2.50
R31	RES FXD COMP	3.30K	.500W	1025	1	1	.20
R32	RES FXD FILM	1.00K	.5W	110269	1	1	2.50
R33	RES FXD W.W.	680.00	3W	110629	1	1	.80
R34	RES FXD COMP	3.90K	.500W	464	3	1	.20
R35	SAME AS R9						
R36	SAME AS R18						
R37	RES. FXD FILM	620.00	.5W	110270	2	1	2.50
R38	SAME AS R10						
R39	RES FXD FILM	6.80K	.5W	110271	6	2	2.50
R40	SAME AS R5						
R41	SAME AS R10						
R42	RES FXD FILM	2.70K	.5W	109203	1	1	1.08
R43	RES VAR W.W.	1.00K	.5W	111227	1	1	4.50
R44	SAME AS R39						
R45	SAME AS R39						
R46	RES FXD FILM	1.80K	.5W	109201	1	1	1.08
R47	RES VAR W.W.	1.0K	2W	107442	1	1	2.50
R48	RES. FXD COMP	470.00	.500W	184	1	1	.20
R49	NOT USED						
R50	SAME AS R9						
R51	SAME AS R18						
R52	SAME AS R39						
R53	SAME AS R20						

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

MODEL 172PC-1

P/N 111621

PAGE NO. 7

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
R54	NOT USED						
R55	SAME AS R5						
R56	SAME AS R39						
R57	SAME AS R39						
R58	SAME AS R37						
R59	RES VAR W. W.	200.00	.5W	111225	1	1	4.50
R60	RES FXD FILM	825.00	.250W	107728	1	1	2.50
R61	SAME AS R10						
R62	NOT USED						
R63	NOT USED						
R64	SAME AS R9						
R65	NOT USED						
R66	NOT USED						
R67	JUMPER	20AWG WHITE		107983	1		
R68	SAME AS R27						
R69	SAME AS R34						
R70	SAME AS R34						
R71	NOT USED						
R72	SAME AS R27						
T1	XFMR PULSE	XFMR	PULSE	111194	1	1	12.00
XQ1	SOCKET, XISTOR	4 PIN		128	17	4	.75
XQ2	SAME AS XQ1						
XQ4	SAME AS XQ1						
XQ3	SAME AS XQ1						

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

PAGE NO. 8

[illegible]

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.

2 - Unit Price shown above is subject to change without prior notice.

3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.

4 - Spare Quantity shown above is recommended quantity for one year isolated service.

MODEL 116HS-5

P/N 111507

PAGE NO. 1

[illegible]

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

PAGE NO. 1 of 1

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

NJE CORPORATION

20 BORIGHT AVENUE, KENILWORTH, NEW JERSEY-07033

A SUBSIDIARY OF



CORPORATION

FACTORY TRAINED LOCAL SERVICE CENTERS

ALABAMA:

Col-Ins-Co., Inc. (205)539-1771
P. O. Box 4246 - Huntsville 35802

CALIFORNIA:

Ronald Olander and Co. (213)469-6313 TWX: (910)321-3915
6313 Santa Monica Blvd., Los Angeles 90038

FLORIDA:

Col-Ins-Co., Inc. (305)423-7615 TWX: (810)850-0134
P. O. Box 13189 - Orlando 32809

GEORGIA:

Col-Ins-Co., Inc. (404)873-5118
418-A Armour Circle N. E., Atlanta 30324
P.O. Box 14077

ILLINOIS:

Carter Electronics, Inc. (312)776-1601
7203 S. Western Avenue - Chicago 60636

MINNESOTA:

Carter Electronics, Inc. (612)869-3261
2401 W. 66th Street - Minneapolis 55423

NEW MEXICO:

Brooks Feeger Association (505)268-4387 Telex: 074-6457
1238 Ortiz, S. E. - Albuquerque 87108

NEW YORK:

Burlingame Associates, Ltd. (914)664-7530 TWX: (710)562-0105
510 South Fulton Avenue - Mt. Vernon

TEXAS:

Brooks Feeger and Puckett, Inc. (713)482-7563 Telex: 077-300
P. O. Box 50 - Friendswood 77546

